US 52 Corridor Study
Tippecanoe County

Final Summary Report

Prepared for:
Tippecanoe County, Indiana

Participating Agencies:
West Lafayette, Indiana
Area Plan Commission of Tippecanoe County Indiana
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US 52 CORRIDOR STUDY
EXECUTIVE SUMMARY

Study Purpose

The purpose of this study is to recommend needed improvements to segments of US 52 and US 231 through West Lafayette and Tippecanoe County. The study includes US 52 from Nighthawk Drive in West Lafayette to CR 500 W in Tippecanoe County and Northwestern Avenue (US 231) from Lindberg Road to US 52 in West Lafayette. The study identifies corridor improvements to address existing problems and to accommodate future growth.

Problem Identification

Problems and deficiencies were identified by evaluating current traffic conditions as well as forecast conditions in 2015 and 2030. This included an assessment of congestion and delay, analysis of vehicle crash records, survey of vehicle travel speeds, review of plans and inspection records, discussions with public agency staff, key stakeholders and the public, and field observation of existing conditions.

Key Problems

- High speeds, particularly west of Yeager.
- High vehicle crash rates at intersections, closely spaced driveways, and median breaks.
- Congestion and inadequate capacity at major intersections as well as between intersections due to high volumes, too few lanes, and closely spaced driveways.
- Weaving (lane changing) south of Cumberland.
- Lack of continuous sidewalks and trails for bicycle, pedestrian and transit accessibility.
- Inadequate drainage east of Yeager.
- Poor pavement condition, particularly on Northwestern north of Yeager.

Recommendations

Recommended improvements were identified primarily through traffic operations analysis and identification of common countermeasures to: reduce speeding and crash problems, improve street design, and improve pedestrian and bicycle access. Candidate improvement concepts were screened and refined through feedback from multiple meetings of the study steering committee and public input. The most significant recommendations are described below. These concepts are designed to improve travel efficiency and safety in the US 52 corridor, but will not solve all identified problems.

US 52 — Nighthawk Drive to Yeager Road

- Street Design. Mid-block-u-turns (a.k.a. "Michigan left turns") are recommended to reduce delay and improve: traffic flow, safety and bicycle and pedestrian access (Figure A19). Under this concept, left turns would be prohibited in all directions at the intersections of US 52 with Yeager Road, Salisbury Street and Nighthawk Drive. These

movements would be accommodated at adjacent intersections. While the concept is new to the community, it is proven to decrease crashes and congestion. Additionally, it is the most bicycle and pedestrian friendly and has the least right-of-way impact of the alternatives that were considered, including the alternative to widen US 52 from 4 to 6 lanes and more at intersections. A series of five new mid-block-u-turn locations would be constructed along US 52 and controlled by traffic signals to accommodate the u-turn movements.

- Traffic Control for Speed Reduction. To improve driver awareness of the westbound US 52 speed reduction near Nighthawk, the existing 40 mph sign should be relocated to improve visibility. Additionally, a "Reduced Speed Limit Ahead" sign should be placed further upstream.
- Alternate Commercial Access. To improve access to shopping areas and reduce traffic on US 52, a system of alternative parallel routes should be built as existing commercial areas are redeveloped.

Pedestrian and Bicycle Improvements

- Additional sidewalk and trail connections, beyond those identified in current plans, are recommended. Trail or sidewalk facilities are proposed on both sides of US 52 and Northwestern Avenue to provide access to adjacent property and transit service. Crossing locations at major intersections should be designed to safely accommodate pedestrians and cyclists, including crosswalks, pedestrian signal indications and median refuge areas. Existing sidewalk and trail facilities should be brought into compliance with the Americans with Disabilities Act. Pedestrian and bicycle overpasses are not proposed as part of this study because of the improved pedestrian crossing provided by the mid-block-u-turn design, the wide medians and sidewalks in the recommended street design, and the lack of use overpasses usually experience. The recommended street design of US 52 for Nighthawk to Yeager is the safest for bicyclists and pedestrians of the alternatives considered.

Northwestern Avenue — Lindberg Road to US 52

- Street Design. This segment should be reconstructed as a 4-lane street with curb, gutter, sidewalk and trail facilities, a raised median and enclosed drainage. Resurfacing north of Yeager is critical in the short term.
- Intersection Improvements. To improve safety and reduce congestion, the intersection of Northwestern with Lindberg Road needs additional travel lanes and pedestrian and bicycle improvements.

US 52 —West of Yeager Road

- Street Design. US 52 from Klondike Road to Yeager Road should be reconstructed with curb, gutter, raised median and enclosed drainage. Sidewalks and multi-use trails should

be provided for pedestrians, transit users and cyclists, and roadway lighting would improve safety for all corridor users.

- Added lanes between Morehouse and Northwestern. US 52 should be widened to 3 lanes in each direction from Morehouse Road to Northwestern Avenue.
- Intersection and Signal Improvements. Additional turn lanes and traffic signal timing improvements are required at several intersections by 2030 in order maintain adequate traffic flow. These include the US 52 intersections with Cumberland Avenue, Morehouse Road, relocated US 231 and Klondike Road. Extending the northbound left turn lane at Cumberland is a short term partial fix.
- New traffic signals. The intersection of US 52 with Paramount Drive warrants a traffic signal, and Wyndham Way could warrant a traffic signal when the Meijer site is developed. These signals would be funded by private developers.
- Northwestern Avenue entrance ramp improvements. Relocating the ramp will provide more weaving space south of Cumberland
- Potential US 52/Northwestern Avenue intersection. The bridge that carries Northwestern Avenue over US 52 should be replaced with an at-grade intersection when it requires major rehabilitation. This would have little impact on traffic operation at this location, but it could improve traffic operation at the US 52/Yeager Road intersection and help reduce traffic speeds.
- Traffic control. Adding flashers to the Signal Ahead warning sign would provide improved warning of upcoming urban conditions west of Klondike Road.
- Parallel road capacity. While not a subject of this study the need for alternate parallel routes to divert local access from US 52 should be considered before land development makes their construction impractical.

Area Wide Recommendations

- Gateway enhancements. Gateway enhancements help to slow traffic, provide information for travelers, and contribute to a unique character of the corridor. Several proposed locations are identified in this study.
- Access Management. Several locations were identified where access management standards need to be applied during the development and redevelopment process to minimize congestion and increase safety.

Projects and Implementation Phasing

Conceptual street layouts were developed and used to develop preliminary estimates of project costs and impacts. Recommended implementation of projects in the short-term (within 5 years), medium-term (5 – 15 years) or long-term (15 – 20 years) is based on the severity of the problems they address and anticipated time requirements for project development. **Table E-1** provides a summary of the recommend projects, project costs, property impacts, and implementation phasing.

Table E-1: US 52 Corridor Study Recommended Projects

Project	Road	Limits	Improvement	Report Section Reference	Estimated Implementation Cost (2010 dollars)	Estimated Impacted Properties
Short-Term Projects						
S-1	US 52	At Klondike Rd.	Add turn lanes and modify signal	5.1.2	$800,000	4
S-2	CR 250 W	Immediately north of US 52	Realign road to US 52/US 231 intersection	5.1.3	$790,000	2
S-3	US 52	Near Klondike and Nighthawk	Warning sign improvements	5.1.5/5.3.4	$32,000	0
S-4	US 52	At Morehouse Rd.	Add turn lanes and new signal	5.2.3	$1,110,000	2
S-5	US 52	At Cumberland Ave.	Lengthen left turn lane on WB US 52	5.2.5	$110,000	0
S-6	US 52	At Cumberland Ave.	Add 2nd left turn lane on WB US 52 and new signal	5.2.4	$710,000	3
S-7	US 52	Northbound entrance ramp from Northwestern Ave,	Relocate entrance ramp	5.2.6	$1,100,000	0
S-8	Northwestern	Neil Armstrong Dr. to US 52 bridge	Resurface road	5.4.2	$190,000	0
S-9	Northwestern	At Lindberg Rd.	Add lanes and replace signal	5.4.3	$1,690,000	8
Mid-Term Projects						
M-1	US 52	Morehouse Rd. to Northwestern Ave.	6-lane urban section	5.2.1	$12,100,000	5
M-2	US 52	Northwestern Ave. to Yeager Road	4-lane urban section	5.2.2	$1,240,000	1
M-3	US 52	Yeager Rd. to Nighthawk Dr.	4-lane with median u-turn intersections	5.3.2	$12,860,000	19
M-4	Northwestern	Lindberg Rd. to Neil Armstrong Dr.	4-lane urban section	5.4.1	$2,200,000	0
Long-Term Projects						
L-1	US 52	Klondike Rd. to Morehouse Rd.	4-lane urban section	5.1.1	$9,570,000	13
L-2	US 52	At future US 231 intersection	Add turn lanes and modify signal	5.1.4	$400,000	0
L-3	US 52	At Northwestern Ave. interchange	At-grade Intersection	5.2.7	$6,630,000	0

[1] Cost estimates are based on conceptual typical sections, preliminary feasible alignments and unit costs. Preliminary engineering has not been performed.

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FINAL SUMMARY REPORT

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1 INTRODUCTION

1.1 Purpose of the US 52 Corridor Study

US 52 is an important regional mobility corridor within the Lafayette-West Lafayette urban area. West of the Wabash River, it is the main arterial roadway serving the north side of West Lafayette and the northwest portion of Tippecanoe County. Portions of US 52 within West Lafayette currently experience congestion and safety problems due to high traffic volumes and dense corridor development with little coordinated access . Development along US 52 continues to move westward from West Lafayette into Tippecanoe County, replacing the rural character of the corridor and bringing increased traffic volumes.

The purpose of this study is to examine the segment of US 52 through West Lafayette and into adjacent Tippecanoe County and identify improvements needed to address existing problems or accommodate long term growth. The study also examines the improvement needs for a short segment of US 231 (Northwestern Avenue) between US 52 and the Purdue University campus. The study examines corridor improvement needs between 2010 and a horizon year of 2030, reflecting anticipated land use development and transportation network changes during that planning period.

The study corridor is shown in **Figure A1**. It includes the segment of US 52 from Nighthawk Drive in West Lafayette to CR 500 W in Tippecanoe County. This segment of US 52 is designated as an urban principal arterial through West Lafayette extending to the western boundary of the federally-approved urban area at CR 400 W. West of this intersection, US 52 is designated as a rural minor arterial. The study corridor also includes a portion of US 231 (Northwestern Avenue) extending from Lindberg Rd. on the south to its junction with US 52. This roadway segment is also designated as an urban principal arterial. West of the US 52/ US 231 junction, US 231 follows US 52. This roadway segment is identified as US 52 in this study.

As stated in the Tippecanoe County Thoroughfare Plan, the primary function of an arterial roadway is to move large volumes of traffic with minimal interruption. These sections of US 52 and US 231 provide the dual function of providing for multimodal access to a highly developed retail and commercial area in West Lafayette, while also providing for travel from more rural areas into and through the City. In addition, these facilities carry a significant amount of traffic to and from Purdue University and are on the designated routes for Purdue special event traffic.

1.2 Study Approach

The goal of this study is to identify safety and traffic operation needs and related potential improvements not only for automobiles, but also for bus, bicycle, and pedestrian modes of travel. The study has two primary components: the first is the evaluation of existing

conditions and the identification of short term improvements to be implemented in a 5 to 10 year time frame, and the second is the evaluation of long term improvements based on forecasted future land use and travel demand.

The project work plan was developed in consultation with a project steering committee that included representatives from the Tippecanoe County Highway and Sheriff's Departments, the Indiana Department of Transportation (INDOT), the Area Plan Commission of Tippecanoe County (APC) and the City of West Lafayette. The study has relied significantly on the cooperation of the steering committee agencies to provide most of the data used in the evaluation and timely reviews of the project findings.

Meetings were scheduled at key points in the study development to both inform stakeholders and the public regarding the study findings as well as solicit comments on potential improvements identified for the corridor. The basic process followed is shown in **Figure A2.**

The final product of the study is an improvement program that provides a detailed description of proposed projects, project costs, and implementation phasing based on a 20 year improvement timeline for the corridor.

2 EXISTING AND FORECAST CONDITIONS

2.1 Land Use and Development

US 52 and US 231 traverse a variety of land uses within the project limits, including "strip" type retail, developing residential areas, a growing technology park and environmentally sensitive wetlands. **Figure A3** shows 2008 aerial photography of the existing land uses in the study corridor.

Traveling from west to east along the corridor, one transitions from a rural agricultural environment to a densely developed suburban setting. Land use is primarily agricultural on the west end of the study area, with the Elks Country Club and the Purdue Agricultural Research facility on the north side of US 52. From CR 300 W (Klondike Road) to Morehouse Road, older, low density residential areas are being redeveloped into high density residential and commercial development. Between Morehouse Road and Yeager Road, development adjacent to US 52 is primarily a mixture of commercial uses and office employment, including over 3,000 employees in the 725-acre Purdue Research Park. A Wal-Mart is located on the southwest side of US 52, near its junction with US 231 (Northwestern Avenue). The Celery Bog Nature Area is also on the southwest side of US 52, immediately behind the Wal-Mart property. This park and the adjacent Birck Boilermaker Golf Complex have limited development on the west side of US 52 and US 231 (Northwestern Avenue) between Cumberland Avenue and Lindberg Road. Farther east, numerous retail shops and "fast food" restaurants are located along both sides of US 52 between Yeager Road and Nighthawk Drive, with established residential neighborhoods located behind the commercial frontage.

East of Cumberland Avenue, the US 52 and US 231 (Northwestern Avenue) corridors are essentially fully developed. Little new development is anticipated in these areas, although redevelopment of some individual sites at higher densities is expected. Current redevelopment sites include the southern portion of the Purdue Research Park, the old Family Inn on Northwestern Avenue, and the Wabash Commons development at Nighthawk Drive.

West of Cumberland Avenue, it is anticipated that existing vacant land in the US 52 corridor will continue to be developed into new commercial, office and residential uses. This development will be accelerated by the relocation of US 231 from its present alignment on Northwestern Avenue to a newly constructed road parallel to McCormick Road. It is expected that this new road will be completed south of US 52 by 2015, and it potentially will be extended north to a new interchange with I-65 by 2030.

As part of this corridor study, the Tippecanoe County APC performed a detailed review of land use forecasts in the US 52 corridor. These revised land use forecasts were used with the APC's travel demand model to update travel demand forecasts for the corridor road network.

2.2 Roadway Function and Design

US 52

The design characteristics and speed limits of US 52 reflect a transition from rural to urban from west to east. From CR 500 W to Yeager Road, US 52 is a divided roadway consisting of two 12-foot lanes and 10-foot shoulders in each direction, separated by a variable-width grass median. This segment of US 52 has open ditch drainage and no adjacent sidewalks or trails. Left turn lanes and paved crossovers are present at certain access points and intersections. Right turn lanes have also been added at certain intersections and driveways.

From Yeager Road to the eastern limits of the corridor study, US 52 consists of two 12-foot lanes in each direction divided by a raised concrete-curbed median with left turn lanes at intersections and median crossovers. This segment of US 52 has concrete curb and gutter with an enclosed drainage system. Sidewalks are present on both sides of US 52 for a portion of the segment between Sycamore Lane and Salisbury Street, and a sidewalk continues on the north side of US 52 and an adjacent frontage road to Nighthawk Drive. Right and left turn lanes are present at the US 52 intersections with Yeager Road, Salisbury Street and Nighthawk Drive. Additionally, acceleration/deceleration lanes exist on each side for traffic entering or exiting US 52 at the SR 443 (Soldiers Home Road) interchange.

From CR 500 W to a point just east of Cumberland Avenue, the original concrete surface of US 52 has been overlaid with asphalt. Some of the shoulders and approaches in this section are newer full-depth asphalt pavement with a retro-fit underdrain system. From the limits of the asphalt overlay to the eastern limits of the corridor study, US 52 consists of concrete pavement with concrete curbs.

US 231(Northwestern Avenue)

From Lindberg Road to Yeager Road, US 231(Northwestern Avenue) is an undivided roadway consisting of two 12-foot travel lanes in each direction with a center left-turn lane for access points. Right and left turn lanes are present at Lindberg Road. The right lane on northbound US 231(Northwestern Avenue) becomes a right-turn-only lane at Yeager Road. This intersection, currently a T-intersection, is scheduled to be reconstructed as a roundabout in 2011. North of this intersection, US 231(Northwestern Avenue) becomes a divided roadway with a grass median as it intersects US 52. The northbound travel lanes merge into one lane and cross over the eastbound lanes of US 52 before merging with westbound US 52. Southbound US 231(Northwestern Avenue) is an at-grade diverge from eastbound US 52 and runs adjacent to the bridge embankment. US 231 follows US 52 from their junction through the western limits of the study area.

From Lindberg Road to a point north of the Yeager Road intersection, the original concrete pavement of US 231 (Northwestern Avenue) has been overlaid with an asphalt surface. The northbound overlay ends approximately 450 feet and the southbound overlay approximately

350 feet north of the intersection. The US 231 northbound roadway is grade-separated from the eastbound US 52 roadway, with a concrete bridge deck consisting of a 16-foot travel lane, 4-foot left shoulder and 8-foot right shoulder. The roadway on both ends of the bridge consists of a single concrete travel lane with asphalt shoulders

There is no continuous sidewalk or trail accommodation along this segment of US 231 (Northwestern Avenue). There is one segment of sidewalk on the east side of the road near Camelback Boulevard, but it is not connected at either end.

2.3 Programmed Projects

Several road projects that will impact travel in the US 52 corridor are now under construction or nearing construction. These include the reconstruction of Cumberland Avenue between Soldier's Home Road and US 52 and its extension west to CR 300 W (Klondike Road), the widening of Yeager Road between US 52 and Northwestern Avenue, and the relocation of US 231. These and other key capacity projects that will impact the study corridor in the near term are identified in the Area Plan Commissions FY 2009 Transportation Improvement Program[1] and are shown in **Table 2-1.**

The US 231 relocation project will have the most significant long-term impact on the US 52 corridor, and it will be important to plan for the associated changes in land use and traffic demand. The new US 231 route will provide a better connection between the north side of West Lafayette, Purdue University and the south side of Lafayette. It will alleviate congestion problems in downtown Lafayette and the Levee area of West Lafayette. Where McCormick Road currently carries less than 5,000 vehicles per day near US 52, the relocated US 231 is projected to carry nearly 30,000 vehicles per day.

[1] The Area Plan Commission of Tippecanoe County, FY 2010-2014 Transportation Improvement Program, Amended March 18, 2010.

Table 2-1: Key FY 2010-2014 Transportation Improvement Projects

Road	Location	Improvement	Phase	Year	Projected Cost
Cumberland	US 52 to 300 W	New Road Construction	RW	2010	$210,526
			CN	2012	$5,000,000
Happy Hollow	US 52 to N. River	Road Reconstruction	PE	2009	$400,000
			RW	2010	$150,000
			CN	2013	$5,248,295
Lindberg	300 W to McCormick	Road Reconstruction / Widening	PE	2010	$250,000
			RW	2010	$150,000
			CN	2012	$2,600,000
McCormick	Cherry to Lindberg	Road Reconstruction / Widening	PE	On Hold	$150,000
			RW	On Hold	$150,000
			CN	On Hold	$1,600,000
Soldiers Home	US 52 to Kalberer	Road Reconstruction / Widening	PE	2010	$631,579
			RW	2013	$480,000
			CN	2014	$6,500,000
Soldiers Home	Kalberer to City Limits	Road Reconstruction / Widening	PE	2011	$650,000
			RW	2012	$750,000
			CN	2013	$8,300,000
Sycamore	US 52 to Salisbury	Traffic Calming	CN	2009	$980,245
US 231	SR 26 to US 52	New Road Construction	RW	2008	$6,720,000
			CN	2009	$26,036,000
US 52	US 231 (650 W) to Cumberland	Road Resurfacing	CN	2009/10	$2,000,000
Yeager	US 52 to Northwestern	Added Travel Lanes	RW	2009/10	$1,317,500
			CN	2011	$2,236,843

Source: Reference 1 and City of West Lafayette Engineer

In addition to the projects identified in the Transportation Improvement Plan, several long-term planned projects that would affect travel in the US 52 corridor are identified in the Area Plan Commission's 2030 Transportation Plan.[2] These additional projects are shown in **Table 2-2**. The map of all projects included in the 2030 Transportation Plan is shown in **Figure A4.** Except for the potential INDOT projects on US 52, which this study will help to identify, travel forecasts developed for this study assume that these long-term improvements will be constructed by 2030.

[2] The Area Plan Commission of Tippecanoe County, Transportation Plan for 2030, Amended June 2007.

Table 2-2: Key Long-Term Planned Transportation Projects

Agency	Road	Location	Improvement	Projected Cost
West Lafayette	Cumberland	Yeager to Salisbury	Road Reconstruction	$1,598,000
West Lafayette	Salisbury	Rainbow to Navajo	Road Reconstruction	$954,000
West Lafayette	Salisbury	At US 52	Intersection Improvement	$1,475,000
West Lafayette	Yeager	Kalberer to City Limits	Rural to Urban Improvement	$1,580,000
Tippecanoe County	Cherry	US 231 (Northwestern) to McCormick	New Road Construction	$3,287,000
Tippecanoe County	CR 75E	CR 600N to Soldiers Home	Rural to Urban Improvement	$7,053,000
Tippecanoe County	CR 500N	CR 225W to CR 75E	Rural to Urban Improvement	$7,265,000
Tippecanoe County	Jackson Highway	Urban Boundary to SR 26	Rural to Urban Improvement	$8,312,000
Tippecanoe County	Jackson Highway	CR 650W to UAB	Rural Improvement	$7,323,000
Tippecanoe County	CR 300 W (Klondike)	US 52 to Lindberg	Four Lane Improvement	$8,619,000
Tippecanoe County	CR 300 W (Klondike)	Lindberg to SR 26	Four Lane Improvement	$4,569,000
Tippecanoe County	Lindberg	SR 26 to 300 W	Four Lane Improvement	$8,238,000
Tippecanoe County	Morehouse	CR 600N to US 52	Rural to Urban Improvement	$12,347,000
Tippecanoe County	Morehouse	County Line to CR 600N	Rural to Urban Improvement	$23,964,000
Tippecanoe County	Soldiers Home	City Limits to N. River	New Road Construction	$2,212,000
Tippecanoe County	Yeager	Curve correction/CR 500N	New Road Construction	$2,300,000
INDOT	US 231	US 52 to I-65	New Road Construction	$106,387,000
INDOT	US 52	CR 300 W (Klondike) to Cumberland	Rural to Urban Improvement	$14,324,000
INDOT	US 52	Cumberland to Yeager	Safety Improvement	$2,398,000

Source: Reference 2

2.4 Traffic Volumes

2.4.1 Existing Traffic Volumes

Historical traffic volumes on US 52 and US 231 (Northwestern Avenue) are shown in **Table 2-3**. From 1999 to 2008, traffic volumes increased throughout the US 52 and US 231 (Northwestern Avenue) corridors. The most significant increases were in the portions of the

US 52 corridor from CR 300 W (Klondike Road) to Morehouse Road and from US 231 (Northwestern Avenue) to Salisbury Street.

Table 2-3: Average Annual Daily Traffic (AADT) Volumes

US 52 Section Limits	1999	2002	2005	2008
1. US 231 North (CR 650 W) to CR 400 W	9,069	8,533	9,084	8,809
2. CR 400 W to C.R 300 W (Klondike)	11,555	13,482	12,365	13,705
3. CR 300 W (Klondike) to C.R 250 W (McCormick)	17,068	19,878	20,954	22,047
4. CR 250 W (McCormick) to Morehouse Rd.	__	25,541	24,077	30,114
5. Morehouse Rd. to Win Hentschel Blvd.	__	__	36,687	32,010
6. Win Hentschel Blvd to Cumberland Ave,	__	__	__	__
7. Cumberland Ave. to US 231 South (Northwestern)	__	34,683	34,861	35,614
8. US 231 South (Northwestern) to Yeager Rd.	17,508	20,534	21,126	21,054
9. Yeager Rd. to Salisbury St.	25,634	28,666	29,219	29,768
10. Salisbury St. to Nighthawk Dr.	__	__	__	__
11. Nighthawk Dr. to SR 443 (Happy Hollow)	30,318	31,043	32,265	31,143
US 231 (Northwestern Ave.) Section Limits	**1999**	**2002**	**2005**	**2008**
12. Oakhurst Dr. to Lindberg Rd.	__	22,584	25,351	25,587
13. Lindberg Rd. to Yeager Rd.	__	__	__	__
14. Yeager Rd. to US 52	10,039	10,583	__	14,888

Source: INDOT counts provided by the APC of Tippecanoe County

Recent 24-hour and 48-hour volume counts at several locations along US 52 and US 231 were available from INDOT. Additional volume counts were conducted along many side street segments by the APC during March and April 2009. Existing morning and afternoon peak hour turning movement volumes at most of the study intersections were also available from INDOT. 12-hour turning movement counts were conducted by INDOT in 2005 through 2008 and used to retime traffic signals on US 52 and US 231 (Northwestern Avenue) in 2009. Counts were obtained from INDOT for the following locations:

- US52/CR 300 W (Klondike Rd.)
- US 52/CR 250 W (McCormick Rd.)
- US 52/Morehouse Rd.
- US 52/Win Hentschel Blvd.
- US 52/Cumberland Ave.
- US52/US 231 (Northwestern Ave.)
- US 52/Yeager Rd.
- US52/Salisbury St.
- US 52/Nighthawk Dr.
- US 231 (Northwestern)/Yeager Rd.
- US 231 (Northwestern)/Lindberg Rd.

Additional peak period turning movement counts (7-9 am and 4:30-6 pm) were conducted for this study during May 2009 at the intersections of US 52/Wyndham Way, US 52/Paramount Drive and US 231 (Northwestern)/Windsor Drive. These counts were conducted while Purdue was not in session, and volumes on the north (Paramount Drive) and south (College Station Apartments) legs of the US 52/Paramount intersection were adjusted based on comparison with APC count information on these streets.

15-minute turning movement counts were also conducted at commercial driveways along US 52 during afternoon peak hours in August 2009. These counts provided information about the relative activity levels at the access points between intersections.

Existing peak hour turning movement volumes for the intersection of US 52 and CR 400 West were estimated using peak hour directional approach volume counts available for US 52 and CR 400 W and an estimation method identified in Chapter 8 of National Cooperative Highway Research Project (NCHRP) Report 255 and Chapter 10 of the Transportation Research Board *Highway Capacity Manual*.[3,4] This method is used to estimate intersection turning movement volumes to match observed inflow and outflow volumes on each leg. A 15-minute turning movement count was conducted at the intersection in March of 2010 to substantiate the turning movement estimates.

A summary of existing morning and afternoon peak hour intersection turning movements in the study area is shown in **Figure A5**. These represent the latest available volume data from counts collected in 2005 through 2009. They have not been adjusted to a common year.

2.4.2 Future Travel Demand

The Area Plan Commission conducted a land use study of the US 52 and US 231 (Northwestern Avenue) corridors that served as the basis for the travel demand forecasts used in this study. The APC updated existing land use and developed new forecasts for 2015 and 2030. These land use forecasts were used to update the APC regional travel demand model and develop estimates of daily traffic volumes on the study area road network for a base year of 2003 and horizon years of 2015 and 2030.

Traffic forecasts from the regional travel demand model prepared by the APC were used to identify travel demand growth in the US 52 and US 231 (Northwestern Avenue) corridors. Model output maps were used to identify the estimated 2-way ADT on each leg of each

[3] Pedersen, N.J., and D.R. Samdahl, *Highway Traffic Data for Urbanized Area Project Planning and Design*, National Cooperative Highway Research Project Report 255, Transportation Research Board, Washington, D.C., December 1982.

[4] *Highway Capacity Manual*, Transportation Research Board, National Research Council, Washington, D.C., 2000.

intersection in the study area. Comparison of the future year (2015 or 2030) model ADT with the base year (2003) model ADT was used to estimate a travel demand growth rate for each intersection leg. The actual existing AM and PM peak hour turning movement volumes at each intersection were then multiplied by these growth rates to determine the estimated 2015 and 2030 turning movement volumes. The growth rate applied to each particular turning movement was the average of the growth rates for its upstream and downstream road segments.

At intersections where the growth rate differs significantly among the various approaches, the method of averaging the upstream and downstream growth rates to identify the turning movement growth rate does not work well. This method tends to underestimate the volumes on high-growth approaches and overestimate the volumes on low-growth approaches. For these intersections, the existing peak hour inbound and outbound volumes on each approach leg were multiplied by the segment growth rates to estimate future inbound and outbound volumes. The future inbound and outbound volumes were then used to estimate turning movement volumes using the NCHRP Report 255 method referenced in the previous section. This method was used for the intersections of US 52 with CR 400 West, Wyndham Way, Future US 231, and Paramount Drive.

An alternate forecast was developed to estimate traffic movements through the interchange of US 52 and US 231 (Northwestern Avenue) if this interchange were to be reconstructed as an at-grade intersection. This reconstruction would allow westbound to southbound left turns (from US 52 to Northwestern) and northbound to eastbound right turns (from Northwestern to US 52) that currently are not accommodated. These movements would primarily be used by traffic traveling to and from Neil Armstrong Drive. It is also possible that the intersection of Neil Armstrong Drive and Northwestern Avenue could be relocated to serve as a west leg for the US 52/Northwestern intersection, but no forecast was developed for this configuration.

A summary of forecast 2015 and 2030 morning and afternoon peak hour intersection turning movements in the study area are shown in **Figure A6** and **Figure A7**.

2.5 Transit & Pedestrian/Bicycle Facilities

2.5.1 Transit Operations

CityBus of Greater Lafayette operates an extensive bus system that serves the Cities of Lafayette and West Lafayette as well as Purdue University. Four regular CityBus routes provide service to parts of the study corridor and generally operate on 30 minute headways. Routes that provide service within the study corridor are shown in **Figure A8**. CityBus previously operated "flag-stop" service on its routes, allowing passengers to signal the bus to stop at any location along the route. It has recently revised this policy to stop only at designated bus stops, which reduces passenger convenience but improves schedule adherence.

The Salisbury route operates 7 days per week, following Salisbury Street and Cumberland Avenue between the Purdue University area and Wal-Mart and adjacent Lodge apartments. In the evening, this route also serves the residential areas west of Salisbury Street by traveling on Navajo Street and Soldiers Home Road to Cumberland Avenue. The Northwestern route operates Monday through Saturday, following Northwestern Avenue, Yeager Road, Kalberer Road and Morehouse Road between the Purdue campus and residential areas near Morehouse Road. The Purdue West/Klondike route follows a loop route between Purdue and the Klondike area that includes service along US 52 from CR 300 W (Klondike Road) to Northwestern Avenue and along Northwestern Avenue from US 52 to Lindberg Road. The Happy Hollow route operates Monday through Friday between the Purdue campus and Kalberer Road, serving Happy Hollow Road, Soldiers Home Road, Cumberland Avenue and Salisbury Street.

CityBus also operates three express routes between Purdue and residential areas to the northwest of campus. The Klondike express follows a loop route similar to the Purdue West/Klondike route, but only operates 2 buses in the morning and 2 in the evening on days that Purdue is in session during the Spring and Fall sessions. Two additional express routes from Purdue serve the Campus Suites and College Station apartment communities, which are both near US 52 and Paramount Drive. Purdue students who reside in those communities may ride for free on buses that run on a 30-minute headway. These routes also operate only on days that classes are in session during the fall and spring semester sessions.

CityBus management indicated that no service expansions are currently planned for the West Lafayette area.[5]

2.5.2 Bicycle and Pedestrian Facilities

A network of trails serves bicyclists and pedestrians within West Lafayette. These include both paved, off-street trails like the Cattail Trail and on-street bicycle lanes like those on Salisbury Street and Cumberland Avenue. Several planned trails will improve bicycle and pedestrian access to the US 52 corridor, including trails along CR 300 W (Klondike Road), relocated US 231, Northwestern Avenue and Yeager Road. Existing and planned facilities are shown in **Figure A8**.

These existing and planned trails, combined with the use of local streets, provide access to most destinations along the US 52 and US 231 (Northwestern Avenue) corridors. Sidewalks also exist along many streets that intersect or parallel US 52 and Northwestern Avenue. These include:

[5] Telephone conversation with John Metzinger, CityBus Manager of Development.

- Covington Street, from US 52 into the neighborhoods to the north
- Cumberland Avenue, from US 52 to Soldiers Home Road
- Kalberer Road, from Purdue Research Park to Soldiers Home Road
- Lindberg Road, from Sheridan Road to Garden Street
- Nighthawk Drive, from US 52 to Navajo Street
- Northwestern Avenue, from Lindberg Road to Purdue University
- Salisbury Street, from Kalberer Road to Lindberg Road and further south
- Soldiers Home Road, from north of US 52 to Cumberland Avenue
- Sycamore Lane, from US 52 to Salisbury Street
- Yeager Road, from Northwestern Avenue to Anthrop Drive

Although pedestrian and bicycle access to specific destinations in the corridor is provided or planned, there is very limited accommodation of cyclists or pedestrians directly along US 52 or along US 231 (Northwestern Avenue). The Nighthawk Trail exists on the north side of US 52 between Nighthawk Drive and Soldiers Home Road. Sidewalk exists along the north side of US 52 from Covington Street to the Beau Jardin Apartments (halfway between Salisbury Street and Yeager Road) and along the US 52 frontage road from Nighthawk Drive to Covington Street. On the south side of US 52, the only continuous segment of sidewalk is between Salisbury Street and the vicinity of the Beau Jardin Apartments. The US 52 intersections with Salisbury Street is the only location where sidewalks and crosswalk are present on all corners. Crossing US 52 or Northwestern Avenue at other locations is often difficult for pedestrians, especially where medians or diagonal intersections contribute to long crossing distances.

2.6 Environmental Conditions and Constraints

A red flag investigation was conducted to identify potential environmental issues or constraints that might affect alternative solutions considered for the corridor. The corridor was reviewed according to the Indiana Department of Transportation (*INDOT) Procedural Manual for Preparing Environmental Documents* (2008). The red flag investigation considered ecological conditions in the study corridor and the potential presence of hazardous materials. It was conducted through a desktop review of existing records and coordination with environmental resource agencies, and supplemented by a cursory field review. A separate Red Flag Investigations Report (March 2010) has been developed and is briefly summarized in this section. **Figure A9** is an environmental constraints map that shows information on streams, potential wetlands and potential hazardous materials sites in the study corridor.

Seven streams in the study corridor were identified as potential "Waters of the U.S.," as designated by the United States Army Corps of Engineers (USACE). Indian Creek is the largest of these streams, and US 52 crosses through the Indian Creek floodplain and floodway

between CR 400 W and CR 300 W (Klondike Road). Any projects that impact these streams could require permits and may require mitigation. Two ponds and several potential wetlands were identified in close proximity to the project, as shown in **Figure A9**. Impacts to wetlands confirmed by the USACE will need to be permitted by the USACE and IDEM. If impacts exceed 0.1 acre, mitigation may be required.

The adjacent habitat and surrounding plant community types provide foraging and breeding for deer, coyote, skunk, raccoon, possum, other small mammals, various bids, amphibians and reptiles. An Endangered Species Review was submitted to the U.S. Fish and Wildlife Service (USFWS) and the Department of Natural Resources Indiana Natural Heritage Data Center. Comments from these agencies indicate that the study area is within the range of several Federal or State endangered species and several candidate species (species being proposed for threatened or endangered status). Proposed projects may need to consider impacts to these species.

A total of 31 hazardous materials sites were found within a half mile of the study area. Included in the sites identified are 21 Underground Storage Tanks (UST), 13 of which are Leaking Underground Storage Tanks (LUST). Furthermore, one Brownfield was identified directly adjacent to US 52, which is identified as Site 22 in the Environmental Data Resources (EDR) Report and shown in **Figure A9**. Other areas of concern include 20 sites that have a known hazardous material spills.

3 CORRIDOR PROBLEM IDENTIFICATION

Existing and future potential problems in the US 52 and US 231 (Northwestern Avenue) corridors were identified through the synthesis of several types of information. This included

- Analysis of crash records
- Analysis of travel speed data,
- Analysis of the traffic operation at key intersections under both existing and forecast 2030 conditions,
- Review of bicycle and pedestrian facility connectivity,
- Discussion of transit service issues with CityBus,
- Review of road plans and inspection records, and
- Field observation.

The problem identification process and findings are detailed in this chapter. **Figure 3-1** through **Figure 3-4** provide reference maps of the study corridors broken into four segments from west to east.

Figure 3-1: US 52 from CR 400 W to Win Hentschel

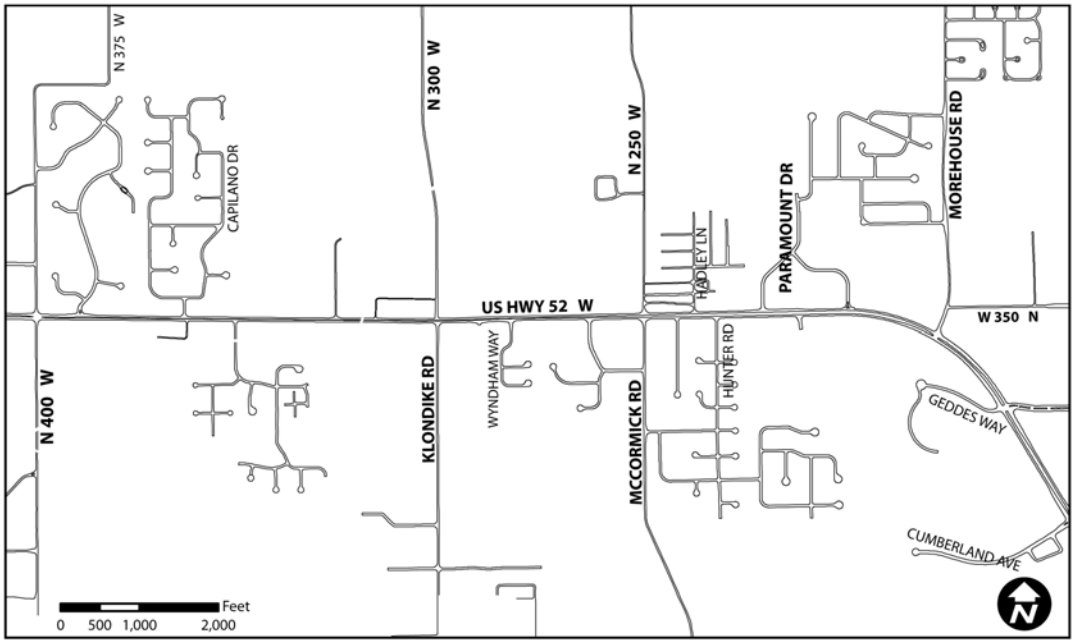


Figure 3-2: US 52 from Win Hentschel to Cumberland

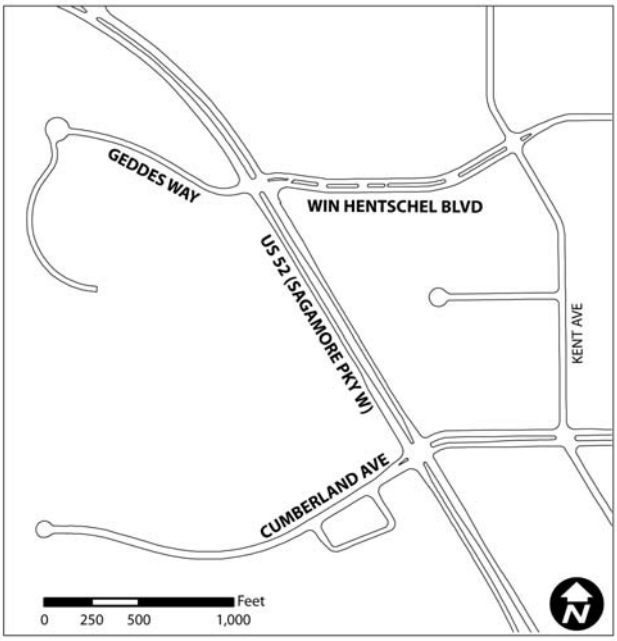


Figure 3-3: US 231 from US 52 to Lindberg

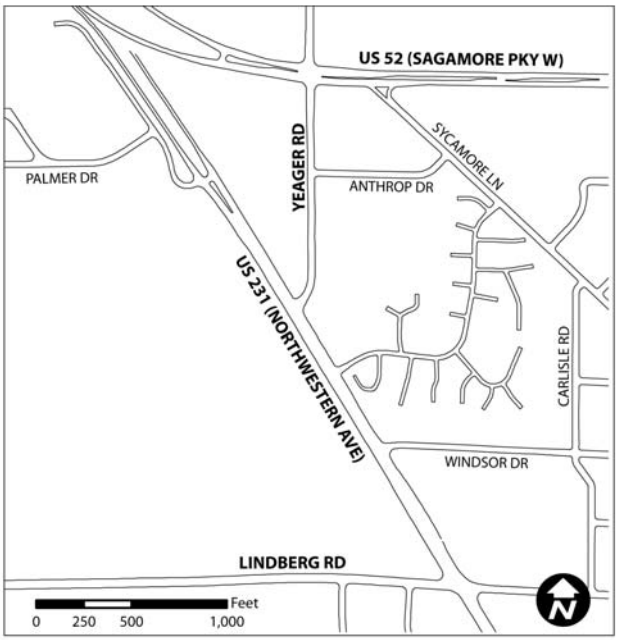
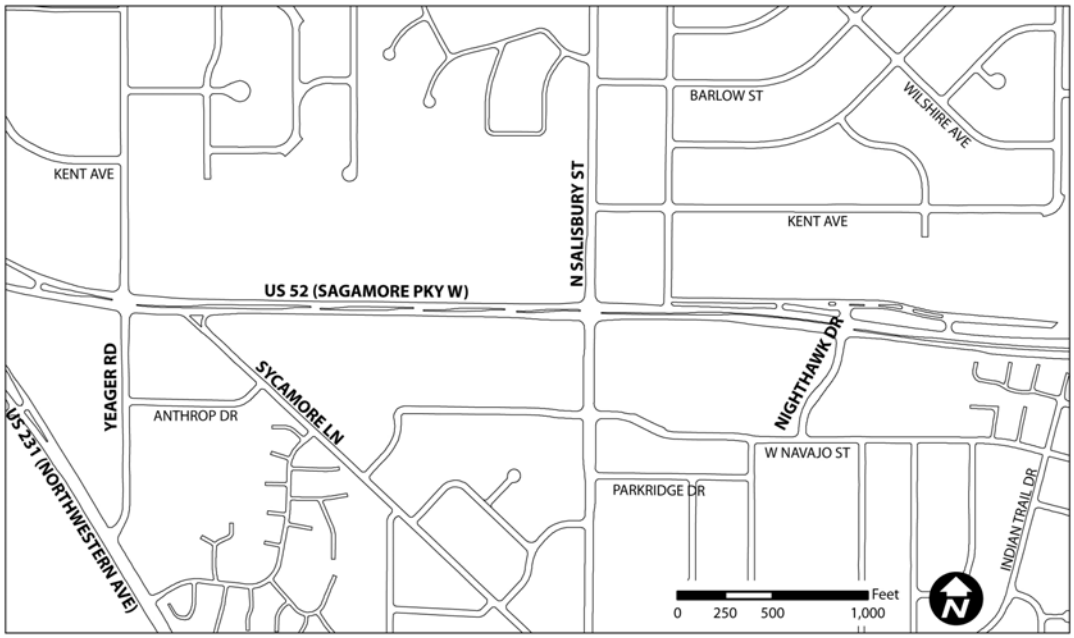


Figure 3-4: US 52 from Yeager to Nighthawk



3.1 Traffic Safety

3.1.1 Vehicle Crashes

Crash data were provided by the Area Plan Commission for three years (2006 – 2008) with geo-coded location information in latitude and longitude. Crashes within 250 feet of a public road intersection were attributed to that intersection.

Potential high crash locations were identified using the hazard analysis methods developed for the Indiana Hazard Elimination Program.[6] Intersection crashes were analyzed using both the Index of Crash Frequency (I_{CF}) and Index of Crash Cost (I_{CC}) defined by the method, where the crash cost index accounts for crash severity. Roadway segments between intersections were analyzed using the crash frequency index only. An I_{CF} or I_{CC} of +2 or greater indicates a high crash location. An I_{CF} or I_{CC} between +1 and +2 indicate a possible high crash location. Locations identified as high crash locations or potential high crash locations are shown in the following tables.

Table 3-1: Intersections with Potential High Crash Frequency, 2006-2008

Intersection	Total Crashes	Daily Entering Vehicles	Crash Frequency Index (ICF)	High Crash Location?
US 52 & CR 300W (Klondike)	39	23,000	1.34	Possible
US 52 & Morehouse Rd	51	35,800	1.03	Possible
US 52 & Cumberland Ave	99	41,300	2.50	Yes
US 52 & Yeager Rd	71	36,600	1.80	Possible
US 52 & Salisbury St	98	43,000	2.34	Yes
US 231 & Yeager Rd	41	25,900	1.21	Possible

Table 3-2: Intersections with Potential High Crash Cost, 2006-2008

Intersection	Daily Entering Vehicles	PDO Crashes	Injury/Fatal Crashes	Crash Cost Index (I_{CC})	High Crash Location?
US 52 & Morehouse Rd	35,800	37	14	1.09	Possible
US 52 & Cumberland Ave	41,300	77	22	2.31	Yes
US 52 & Yeager Rd	36,600	55	16	1.59	Possible
US 52 & Salisbury St	43,000	81	17	1.78	Possible

[6] Tarko, A. and M. Kanodia, Hazard Elimination Program - Manual on Improving Safety of Indiana Road Intersections and Sections, Volume 2: Guidelines for Highway Safety Improvements in Indiana, Report FHWA-IN-JTRP-2003-19, February 2004.

Table 3-3: Road Segments with Potential High Crash Frequency, 2006-2008

Road	Segment Location	Facility Type	Length (ft)	Total Crashes 2006-2008	Daily Entering Vehicles	Crash Frequency Index (I_{CF})	High Crash Location?
US 52	Sycamore to Salisbury	Urban Multilane	1570	50	29,800	2.20	Yes

Several of the identified high-crash locations were analyzed in more detail to identify potential contributing factors to crash problems. Analysis results are provided below:

US 52 & Morehouse Road

A summary of crashes by type and direction is shown in **Table 3-4**. Eastbound US 52 crashes were most prevalent at this intersection, with rear end crashes being most common. High speed may be a contributing factor. Signal visibility is somewhat limited for eastbound drivers, but is adequate for the travel speeds. Glare was mentioned as a factor in one eastbound crash. Most angle crashes were caused by westbound US 52 vehicles, including one that resulted in a fatality.

Table 3-4: US 52 & Morehouse Road Crashes by Type and Direction

Crash Type	Direction of Vehicle at Fault				
	Northbound Driveway	Southbound Morehouse	Eastbound US 52	Westbound US 52	Total
Rear End	0	3	19	7	29
Same Direction Sideswipe	0	0	2	0	2
Left Turn	0	0	5	1	6
Angle	0	2	1	6	9
Ran Off Road	0	0	3	1	4
Right Turn	0	1	0	0	1
Total	0	6	30	15	51

US 52 & Cumberland Avenue

A summary of crashes by type and direction is shown in **Table 3-5**. Rear end crashes are by far the most prevalent type at this intersection. These crashes, along with same direction sideswipe crashes are approximately evenly distributed on both approaches of US 52. This may be associated with high travel speeds in both directions (see **Figure A10**). Crash records did not identify a specific crash problem caused by the weaving (lane changing) of northbound vehicles on the segment of US 52 between US 231 (Northwestern Avenue) and Cumberland, although some of the rear end and sideswipe crashes on northbound US 52 could be associated with drivers distracted by weaving maneuvers. Vehicle conflicts have

been observed among vehicles. Signal visibility does not appear to be a problem. Existing signal clearance intervals should be checked by INDOT.

Table 3-5: US 52 & Cumberland Avenue Crashes by Type and Direction

Crash Type	Direction of Vehicle at Fault				
	Northbound US 52	Southbound US 52	Eastbound Cumberland	Westbound Cumberland	Total
Rear End	31	27	13	0	71
Same Direction Sideswipe	3	5	1	0	9
Left Turn	0	1	7	2	10
Angle	1	1	2	0	4
Total	35	34	23	2	94

Cumberland Avenue crashes on the west side of US 52 are much more frequent than on the east side. This is likely due to the higher traffic volumes and nearby driveways. Left turn crashes involving eastbound left turning vehicles (leaving the Wal-Mart/University Inn area) are reflective of the high left turn volumes and the lack of a protected left turn phase.

US 52 & Yeager Road

A summary of crashes by type and direction is shown in **Table 3-6**. Rear-end crashes are the most prevalent type at this intersection also. The westbound US 52 approach has experienced a much higher number of crashes than the other approaches. This is likely caused by the queuing on this approach during congested conditions and the adjacent upstream commercial driveways. Westbound left turns are particularly heavy, and queues that spill back into the through travel lanes can contribute to rear-end crashes. The relatively high number of westbound to southbound left turn crashes is indicative of the high left turn volumes, high travel speeds on the opposing eastbound US 52 approach and the fact that this movement operates close to its capacity. Some left-turning drivers are probably selecting gaps that are too short for the high speeds of oncoming vehicles. Vehicles entering the gas station on the southwest corner of the US 52/Yeager Road intersection have been observed to cause southbound queues on Yeager Road that extend into the intersection, although crash records show no evidence that this has caused crashes at the intersection.

Table 3-6: US 52 & Yeager Road Crashes by Type and Direction

Crash Type	Direction of Vehicle at Fault				
	Northbound Yeager	Southbound Yeager	Eastbound US 52	Westbound US 52	Total
Rear End	6	5	5	21	37
Same Direction Sideswipe	2	0	0	0	2
Left Turn	1	0	3	8	12
Angle	2	4	3	2	11
Total	11	9	11	31	62

US 52 & Salisbury Street

A summary of crashes by type and direction is shown in **Table 3-7**. Eastbound US 52 rear-end crashes are twice as numerous as those on other approaches. These mostly occur in the afternoon, and queuing and interference from adjacent upstream driveways are likely contributing factors.

Table 3-7: US 52 & Salisbury Street Crashes by Type and Direction

Crash Type	Direction of Vehicle at Fault				
	Northbound Salisbury	Southbound Salisbury	Eastbound US 52	Westbound US 52	Total
Rear End	10	12	22	10	54
Same Direction Sideswipe	4	3	7	6	20
Left Turn	3	1	3	4	11
Angle	7	0	0	4	11
Total	24	16	32	24	96

US 52 Segment from Sycamore to Salisbury

A summary of crashes by type and location within this segment is shown in **Table 3-8**. Over 80% of the crashes in this segment occurred at the three locations with median openings, and over 40% occurred at one location. The significant number of angle crashes probably reflects lack of adequate gaps in traffic for vehicles exiting these driveways. The rear-end crashes are an expected result of vehicles slowing to enter driveways or let traffic out of driveways. Some may also be caused by queuing along US 52 during congested conditions.

Table 3-8: US 52 Segment from Sycamore to Salisbury Crashes

Crash Type	Number		Crash Location	Number
Rear End	16		McDonalds/Payless Drive	21
Same Direction Sideswipe	9		Payless/Old Jewel Drive	11
Left Turn	5		Mr. & Mrs. Tire Drive	10
Right Turn	2		Other	8
Angle	18		Total	50
Total	50			

3.1.2 Travel Speeds

In 2007, INDOT conducted spot speed studies along US 52 between CR 300 W (Klondike Road) and Cumberland Avenue. In 2009, the Tippecanoe County Sherriff's Department collected supplemental spot speed data along US 52 between Morehouse Road and Nighthawk Drive. These data were analyzed as part of this study.

Figure A10 shows a comparison of speed limits on US 52 with the "85th percentile speeds" identified at various locations. The 85th percentile speed is the speed at or below which 85 percent of vehicles are traveling under free flowing conditions. According to the Indiana Manual on Uniform Traffic Control Devices, posted speed limits should normally be set within 5 mph of the 85th percentile speed. Other factors such as road characteristics, roadside development, parking and pedestrian activity, and crash experience can also be considered.[7] 85th percentile travel speeds on US 52 were measured to be within 5 mph of the speed limit through much of the of the study area. The exceptions were in the following three areas:

a. West of CR 300 W (Klondike Road) speeds were higher for vehicles traveling in both directions (62 mph 85th% vs. 55 mph limit).
b. In the segment between Cumberland Avenue and Yeager Road, westbound speeds are higher (85th% is 8.3 mph over the 45 mph speed limit).
c. At the east end of the study area, westbound vehicles are still traveling fast due to the lack of development and the speed limit of 55 mph over the Wabash River. While the speed limit drops to 45 mph between Happy Hollow and Nighthawk and to 40mph between Nighthawk and Salisbury, westbound vehicles are still traveling over 47 mph (85th %) until Salisbury Street.

These areas of higher travel speeds generally correspond to segments of the US 52 corridor where there is less roadside development, larger distances between intersections and fewer driveways. These conditions make drivers more comfortable traveling at a faster speed. The faster speeds, however, can lead to more crashes and more severe crashes, especially where

[7] Indiana Manual on Uniform Traffic Control Devices for Streets and Highways, 2008 Edition, Section 2B.13.

these "limited development" segments end and drivers must adjust to more congested conditions.

85th percentile speeds measured on Northwestern between Lindberg Road and Yeager Road were within 3 mph of the 45 mph speed limit. Near the merge with US 52 however, northbound 85th percentile speeds were 51.5 mph, which is 6.5 mph faster than the 45 mph speed limit.

3.2 Traffic Operations

Intersection traffic operation was analyzed at all signalized intersections and key unsignalized intersections in the study area under both existing 2009 conditions and forecast traffic demand conditions in 2030. The 2030 conditions under which the intersection traffic operations were analyzed included implementation of the planned and programmed projects identified in **Table** 2-2 and **Table 2-3**.

Synchro traffic analysis software was used to conduct an evaluation of Highway Capacity Levels of Service (LOS) for the intersections during the morning and afternoon peak hours, using the methods of the Highway Capacity Manual, 2000 Edition (HCM).4 The LOS is a quantitative measure that describes the quality of operating conditions within the traffic stream and the perception of motorists regarding traffic operation. The LOS of an intersection is based on the total delay experienced by vehicles waiting to travel through the intersection. The LOS is based on a scale of "A to F", with "A" being the best situation. **Table 3-9** describes the specific LOS criteria for signalized and unsignalized intersections.

Table 3-9: Level of Service Criteria for Signalized and Unsignalized Intersections

LOS	Average Delay (Seconds/Vehicle)	
	Signalized Intersections	Unsignalized Intersections
A	$\leq$ 10	$\leq$ 10
B	> 10 and $\leq$ 20	> 10 and $\leq$ 15
C	> 20 and $\leq$ 35	> 15 and $\leq$ 25
D	> 35 and $\leq$ 55	> 25 and $\leq$ 35
E	> 55 and $\leq$ 80	> 35 and $\leq$ 50
F	> 80	> 50

Source: Reference 4

In addition to LOS for individual intersections, the HCM provides a method for evaluating the LOS of an urban street comprised of multiple intersections. The LOS for a street segment is based on the average travel speed of vehicles as they traverse the segment, which reflects both the design of the road and delays due to congestion and traffic signals. As with

individual intersections, the LOS for urban street segments is based on a scale of "A to F", with "A" being the best situation. **Table 3-10** describes the specific LOS criteria for Class I and Class II urban streets. The classification is based on the free-flow speed that vehicles would travel through the majority of the segment length if there were no restrictions. US 52 is a Class I street and US 231 (Northwestern Avenue) is a Class II street.

Table 3-10: LOS Criteria for Class I and II Urban Streets

LOS	Average Travel Speed (Mph)	
	Class I Streets (45–55 mph Free-flow speed)	Class II Streets (35–45 mph Free-flow speed)
A	> 42	> 35
B	> 34 and ≤ 42	> 28 and ≤ 35
C	> 27 and ≤ 34	> 22 and ≤ 28
D	> 21 and ≤ 27	> 17 and ≤ 22
E	> 16 and ≤ 21	> 13 and ≤ 17
F	≤ 16	≤ 13

Source: Reference 4

Chapter 55 of the Indiana Design Manual provides minimum LOS criteria for traffic operation on multilane rural and urban arterials. For rural and suburban multilane arterials, a peak hour intersection LOS of "D" is the minimum acceptable operating condition, while a peak hour LOS of "B" is desirable. For urban multilane arterials in what INDOT classifies as intermediate" areas, which roughly corresponds to the segments of US 52 and US 231 (Northwestern Avenue) east of their merge, a peak hour road segment or intersection LOS of "D" is the minimum acceptable operating condition, while a peak hour LOS of "C" is desirable. For intersections, these values represent the overall intersection LOS, but the LOS for an individual lane group or approach may be lower. While a lane-group or approach LOS should not be more than one LOS below the overall intersection LOS, this may not always be practical, especially for left-turn lanes or lower volume side streets. Overall intersection LOS is not defined for those intersections where only the minor street is controlled and the main street has no delay. Low volume minor streets might experience long delays at a stop sign, with LOS E or F, but still not warrant additional traffic control.

Currently, all signalized intersections within the study area, both on US 52 and on US 231 (Northwestern Avenue), are synchronized to improve traffic progression on these arterials. The traffic signals operate on a common cycle length of 100 seconds in the morning peak period and 136 seconds in the evening peak period. The intersection of US 231 (Northwestern Avenue) with Yeager Road operates on a cycle length of 50 seconds in the morning peak period and 68 seconds in the afternoon peak period. These cycles are one-half the length of the cycles used at the other signals, allowing lower delay at this intersection while

still providing good progression through the adjacent Lindberg Road intersection half of the time. In general, shorter signal cycle lengths impose less delay on traffic, thus providing better LOS. However, signal cycles that are too short may not provide adequate capacity to serve demand.

The intersections of US 52 with CR 400 W, Wyndham Way and Paramount Drive are not currently signalized. A planning-level analysis was conducted for these intersections to determine whether they might warrant traffic signals with existing volumes or with forecast 2015 or 2030 demand volumes. This analysis was conducted using existing or forecast average daily traffic (ADT) volumes and the ADT criteria provided in Table 4C-2 of the Indiana Manual on Uniform Traffic Control Devices.[7] The analysis indicated that the intersection of US 52 and Paramount Drive may meet traffic signal warrants now and that the intersection of US 52 and Wyndham Way is expected to meet signal warrants by 2015. The intersection of US 52 and CR 400 W is not expected to meet signal warrants by 2030. These results are only preliminary indications of when an intersection may meet traffic signal warrants that must be verified using more extensive traffic counts and the procedures of the MUTCD. INDOT has, in fact, verified that a signal is warranted at the intersection of US 52 and Paramount Drive, and it is currently pursuing installation of a traffic signal at this location under a prior agreement with the adjacent land developer.

Figure A11 and **Figure A12** show the lane configurations, traffic control and traffic operations Levels of Service at each intersection for existing conditions and forecast 2030 conditions, respectively. Significant analysis results are discussed below. Although the analyses explored some potential improvements to better define specific problems, potential solutions will be developed in greater detail in the next phase of the study.

Overall Road Segment Levels of Service for US 52 and US 231 (Northwestern Avenue)

Summaries of the urban street segment LOS for US 52 and for US 231 (Northwestern Avenue) are provided in **Table 3-11**. Overall average travel speeds on US 52 are currently acceptable when the entire study corridor is considered as a whole. However, average travel speeds on specific portions of the corridor are lower than LOS D and are thus unacceptable. This is the case from Yeager to Nighthawk in both the AM and PM peak hours and also from Morehouse to Yeager during the PM peak hour. By 2030, the unacceptable LOS conditions are also present in the segment between CR 300 W (Klondike) and Wyndham Way and in the segment between relocated US 231 and Paramount Drive.

LOS on Northwestern Avenue is currently acceptable during the peak hours. Software analysis results, as shown in the table, projected unacceptable LOS in the peak direction (southbound in the morning and northbound in the evening) by 2030. However, these results are considered inaccurate, as the software calculation method did not appear to properly

account for the proposed roundabout at Northwestern and Yeager. It is anticipated that street segment LOS on Northwestern Avenue will continue to be acceptable through 2030.

Table 3-11: Peak Hour Urban Street Segment LOS Summary

US 52 Cross Street	Eastbound/Westbound Segment LOS			
	2009 AM Peak	2009 PM Peak	2030 AM Peak	2030 PM Peak
CR 300 W (Klondike)	B/B	C/B	B/E	D/E
Wyndham			C/C	D/C
Relocated US 231			D/D	E/E
CR 250 W (McCormick)	A/A	A/A		
Paramount			C/C	B/B
Morehouse	B/C	B/F	C/E	B/F
Win Hentschel	C/D	F/C	C/C	C/D
Cumberland	C/B	F/C	C/B	F/D
Yeager	E/B	F/C	E/C	F/C
Salisbury	E/F	F/F	F/F	F/F
Nighthawk	E/D	E/E	D/D	F/F
Total Corridor	C/C	D/D	C/D	E/E
US 231 (Northwestern) Cross Street	Northbound/Southbound Segment LOS			
	2009 AM Peak	2009 PM Peak	2030 AM Peak	2030 PM Peak
Lindberg	C/D	D/C	C/E[1]	E/D[1]
Yeager	B/A	D/A	C/E[1]	E/D[1]
Total Corridor	C/B	D/B	C/E[1]	E/D[1]

[1]LOS anticipated to be better than reported results.

US 52 & CR 400 W

a. Existing traffic control and lane configurations should be adequate through 2030. The CR 400 W approaches are expected to experience long delays during peak hours, but are not expected to have sufficient volume to meet traffic signal warrants.
b. A northbound right turn lane on CR 400 W could be considered to accommodate anticipated AM peak demand (120 vehicles per hour), although the existing large radius likely allows free movement of right turns under most conditions.

US 52 & CR 300 W (Klondike Road)

a. The existing signal is split phase for the side street, which means that it serves the northbound and southbound approaches of CR 300 W (Klondike Road) separately instead of concurrently. This appears to have been originally due to lack of turn lanes on the northbound and southbound approaches. Turn lanes are now present, although they are possibly not long enough for peak conditions. INDOT reports that split phasing is maintained due to a very short southbound left turn lane, high southbound left turn demand and conflicting northbound right turn demand. No alignment issues appear to

restrict concurrent north/south operation. Lengthening southbound left turn lane would require widening to the west side, as the east side is a cemetery. Underground utilities (at least power and fiber optic) appear to be present. Modification to allow concurrent operation of the northbound and southbound approaches would be beneficial.

b. Large westbound US 52 left turn volume exists in the PM peak period, with current volumes of 360 vehicles per hour forecast to grow to 500 vehicles per hour by 2030. The existing volume is sufficient to warrant a second left turn lane on US 52, but CR 300 W (Klondike Road) currently has only a single receiving lane. Widening would be required on US 52 and on the south approach of CR 300 W (Klondike Road) to accommodate the additional westbound left turn lane. Some right-of-way could be required.
c. Northbound left turn queues will eventually exceed the length of the left turn lane during the PM peak hour. Approach widening would be required to extend this turn lane. This segment of CR 300 W (Klondike Road) is targeted for widening to 4 lanes in the 2030 Transportation Plan.
d. Northbound right turn volumes from Klondike Road to eastbound US 52 are high. A northbound right turn lane will be needed by 2030 to provide acceptable LOS in the PM peak.
e. A paved area on the east side of the south approach is used for parking. This area appears to be within the CR 300 W (Klondike Road) right-of-way. This area may need to be used for widening.

US 52 & Wyndham Way

a. Existing southbound traffic exiting Menards experiences long delays in the PM peak hour (LOS F), but volumes are not sufficient to warrant a traffic signal.
b. This intersection is expected to meet traffic signal warrants by 2015 based on additional development adjacent to Menards. A traffic signal was assumed in the 2030 analysis.
c. It is assumed that a southbound left turn lane will be provided on the Menards driveway when the signal is constructed.
d. Southbound still experiences long delays in 2030 with a traffic signal due to the long cycle length of the signal. Capacity improvements at other intersections may allow the use of a shorter cycle length for all signalized intersections in the study area. It may also be possible to reduce delay by operating the Wyndham Way intersection at a cycle half the length of adjacent intersections.

US 52 & Relocated US 231

a. Final Design Summary Plans (August 2007) provided by INDOT show the new US 231 south of US 52 ending at a "T" intersection with US 52, with no realignment of the north CR 250 W approach into this intersection. Although modeling of 2015 traffic conditions indicated acceptable conditions, the short offset between the relocated US 231 intersection and the existing CR 250 W to be maintained north of US 52 could cause

operational or safety problems. Maintaining this offset intersection is not a desirable design.

b. The 2030 analysis assumed that US 231 will be extended north of US 52 by 2030, which is consistent with the current APC Transportation Plan for 2030.
c. This intersection operates near capacity in 2030, with LOS of E or F for several movements in the PM peak hour. Demand for the westbound US 52 and southbound US 231 left turn movements exceeds the capacity of these movements.
d. High westbound US 52 left turn volumes will require a 2nd left turn lane to meet minimum LOS standards by 2030.

US 52 & CR 250 W (McCormick Road)

a. The CR 250 W and McCormick Road approaches currently experience LOS of "E" and "F" in the PM peak due to the long signal cycle lengths. These are low volume approaches and this intersection will be reconfigured/removed with the US 231 relocation project.
b. The south McCormick Road leg of this intersection will be closed after US 231 is constructed south of US 52. However, until US 231 is constructed north of US 52, the north leg of the US 52/CR 250 W intersection is proposed to be maintained in its current location. The short separation between the US 231 intersection and the CR 250 W intersection could cause operational or safety problems. Traffic analysis was conducted using forecast 2015 volumes and this anticipated interim configuration and did not indicate a problem.
c. It is assumed that this intersection will not exist in 2030. Traffic will be routed through the US 52 & relocated US 231 intersection.

US 52 & Paramount Drive

a. INDOT indicates that this intersection currently meets traffic signal warrants. A traffic signal was assumed in the future year analyses.
b. Good engineering practice requires separate left turn lanes for the northbound College Station and southbound Paramount approaches when it is signalized.

US 52 & Morehouse Road

a. The eastbound US 52 left turn, westbound US 52 through and southbound Morehouse Road left turn movements are all currently at or exceeding capacity in the PM peak hour. A 2nd eastbound left turn lane could improve LOS, but not to acceptable levels. A 2nd receiving lane would be needed on the north Morehouse Road leg in this case.
b. The southbound Morehouse Road lane configuration could provide a shared through/left turn lane and left turn lane. An additional southbound left turn would improve LOS. Nearly all southbound left turn vehicles are coming from the north on Morehouse Road. Vehicles coming from CR 350N nearly all turn right onto westbound US 52.

c. 2030 PM LOS is still poor with the improvements mentioned above due to high volumes of through traffic on US 52.

US 52 & Win Hentschel Boulevard

a. The westbound left turn movement from Win Hentschel experiences excessive delay during the existing PM peak hour and during both the AM and PM peak hours in 2030. High volumes on US 52 force long traffic signal cycle lengths and only allow a short time to service Win Hentschel movements.

US 52 & Cumberland Avenue

a. Eastbound Cumberland left turn and southbound US 52 through movement demand volumes currently exceed capacity in the PM peak hour.
b. The northbound US 52 left turn volume (toward Wal-Mart) is at capacity during the PM peak hour and could possibly warrant a second left turn lane.
c. The eastbound left turn volume from Cumberland to US 52 is high enough to consider permitted-protected left turn phasing. There have been 7 eastbound to northbound left-turn crashes in 3 years. The opposing through volume is relatively low, however.
d. By 2030, the intersection as a whole will experience demand volumes exceeding capacity in the PM peak hour, with an unacceptable overall intersection LOS of E. Northbound US 52 left turn movement, the southbound US 52 through movement and the eastbound Cumberland Avenue left turn movement will all have demand volumes that exceed capacity during the PM peak hour. These movements, plus the southbound US 52 left turn, will have unacceptable LOS of E or F..
e. There is a significant amount of weaving (lane changing) among northbound vehicles on US 52 between the US 231 (Northwestern Avenue) entrance ramp and Cumberland Avenue. This weaving reduces the capacity of the road segment.
f. The horizontal curve on Cumberland Avenue east of US 52 and the vertical grade of Cumberland Avenue west of US 52 both limit the sight distance for drivers approaching the intersection on Cumberland Avenue.
g. The separation distance along Cumberland Avenue between US 52 and the Wal-Mart and Applebees driveways is insufficient to provide appropriate auxiliary lanes for the US 52/Cumberland Avenue intersection and for the driveways. This results in queuing and blockage problems on Cumberland Avenue.

US 52 & Yeager Road

a. Westbound US 52 left turn, northbound Yeager through and southbound Yeager left turn movements currently experience poor LOS during the PM peak.
b. Westbound US 52 left turn, northbound Yeager through and southbound Yeager left turn movements all experience poor LOS and demand exceeding capacity during the PM peak in 2030.

c. High volumes and long delays for westbound US 52 left turns could warrant a 2nd left turn lane. A second receiving lane will exist on the south leg after Yeager is widened, but widening would also be required along US 52. There does not appear to be sufficient right-of-way to accommodate this.
d. A 2nd southbound left turn lane on Yeager Road will likely be warranted by 2030. This additional lane would improve intersection LOS. Adding this lane would require widening this approach, and the turn lane would cause a misalignment of the north and south approaches.
e. A 2nd southbound through lane could be added on Yeager Road north of the intersection, but this would not improve LOS very much.
f. A 2nd northbound through lane on Yeager Road would improve intersection operation significantly, but widening would be needed to accommodate this lane.

US 52 & Salisbury Street

a. Eastbound US 52 through, westbound US 52 left, northbound Salisbury through and southbound Salisbury left turn movements all currently experience significant delay and volumes at or exceeding capacity in the PM peak. Eastbound US 52 through, westbound US 52 left turn and southbound Salisbury through movements all currently experience significant delay and volumes at or exceeding capacity in the AM peak.
b. Additional lane capacity is required on all approaches
c. Significant queuing was observed on both US 52 approaches during the PM peak hour. Queues were several hundred feet long and blocked vehicle access to left turn storage bays.

US 52 & Nighthawk Drive

a. Insufficient separation and storage space exists between US 52 and the frontage road on the north side. This causes queuing problems and vehicle conflicts within the frontage road intersection. It also causes inefficient use of the green phase for southbound Nighthawk, as cars must stop at the stop sign and yield the right-of-way to northbound vehicles before proceeding through the signalized intersection.
b. Eastbound US 52 through, westbound US 52 left turn and southbound Nighthawk left turn movements are all expected to be at or slightly exceeding capacity in the 2030 PM peak. Eastbound and westbound capacities on US 52 are currently acceptable.
c. The southbound left turn movement from Nighthawk has an existing volume of approximately 140 vehicles per hour in the PM peak and is at 95% of its capacity, although the opposing through volume is low. It could warrant a protected left turn phase.
d. Adding a northbound right turn lane on Nighthawk would provide acceptable LOS for the intersection in the 2030 PM peak. The trail along Nighthawk would need to be moved east to accommodate this lane, potentially requiring some land acquisition.

Northwestern Avenue & Yeager Road

a. Current traffic operation is acceptable.
b. A 2-lane roundabout is under design for this intersection. Preliminary operational analysis was conducted using the RODEL traffic model with forecast 2030 traffic volumes and the lane configuration shown in plans supplied by the City of West Lafayette. This analysis indicated future operation will be good, with LOS of "A" on all approaches during the peak hours.
c. Roundabout installation should reduce intersection crashes.

Northwestern Avenue & Lindberg Road

a. Westbound through and eastbound left turn movements on Lindberg Road currently operate with poor LOS during the PM peak, although volumes are within capacity limits. The problem is much greater in 2030, with both movements exceeding capacity.

Morehouse Road & CR 350 N

a. Traffic was observed to queue 7 to 8 cars deep on CR 350 N during the PM peak. Almost all of this traffic is destined to westbound US 52. Most of the traffic approaching from the north on Morehouse road is destined to eastbound US 52.

3.3 Geometric Deficiencies

3.3.1 Geometric Standards

The geometric design features of US 52 and US 231 (Northwestern Avenue) within the study area were reviewed against published design criteria using visual inspection of aerial photographs, on-site observation and limited review of construction plans. Geometric design criteria for multilane arterial road in rural and urban areas are provided in Chapter 55 of the INDOT Design Manual.[8] While no detailed measurements were made, it does appear that these roads generally meet or exceed minimum design criteria for pavement and shoulder widths, median widths, ramp geometry, bridge clearances, horizontal clearances, obstructions and sight distance restrictions. According to the Design Manual, urban arterial roads in what INDOT calls "suburban" or "intermediate" surroundings can be either curbed or have shoulders. The use of shoulder sections and ditches along US 231 (Northwestern Avenue) north of Lindberg Road and on US 52 west of Yeager Road, while consistent with the design criteria, provides a more open feeling to drivers that likely contributes to higher speeds. Development setbacks and intersection spacing contribute to this open feeling.

One area of concern is the horizontal clearance between westbound US 52 and the cemetery on the northeast corner of US 52 and CR 300 W (Klondike Road). The intended obstruction-

[8] Indiana Department of Transportation, Indiana Design Manual, Tables 55-3A and 55-3E, 2010 online edition, available at http://www.in.gov/dot/div/contracts/standards/dm/english/index.html

free horizontal clearance of 20 feet from the edge of the travelway is not provided in this location, even though it technically meets design guidelines because the cemetery is outside of INDOT right-of-way. Sight distance along US 52 at the Morehouse Road intersection will also be evaluated in more detail during a future field visit due to the crash history at this intersection.

3.3.2 Driveway Access

The large number of closely-spaced driveways between Yeager Road and Nighthawk Drive, coupled with poor traffic flow and accessibility through private parking lots, contributes to congestion and safety problems on US 52. The segment between Yeager Road and Salisbury Street is the worst problem area and is identified as a high crash location. There are 16 driveways on the north side of this US 52 segment, with an average spacing between driveways of 153 feet. There are 10 driveways on the south side, with an average spacing between driveways of 245 feet. The INDOT *Driveway Permit Manual*[9] recommends a minimum spacing of 300 feet between adjacent driveways along street with operating speeds of 40 mph.

Driveway traffic in this segment of US 52 was observed to contribute to safety problems. Vehicles exiting the McDonalds/KFC driveway were observed accepting smaller than desirable gaps after waiting for traffic on US 52. In addition, vehicles entering this driveway sometimes conflicted with exiting vehicles due to poor driveway configuration.

US 52 is a limited access facility west of Yeager Road, but it has many driveway cuts and median crossovers. These do not appear to cause problems currently, as volumes at these driveways are low. However, safety and congestion problems associated with these driveway cuts are likely to worsen as development intensity increases.

3.3.3 Pavement and Drainage

The US 52 pavement has been recently resurfaced from Cumberland Avenue west. Pavement east of Cumberland Avenue is in fair condition. Pavement on US 231 (Northwestern Avenue) north of Yeager Road is in extremely poor condition and in need of resurfacing or reconstruction.

During a moderately heavy rain event, significant ponding of water was observed at several locations on US 52 between Yeager Road and Nighthawk Drive. The problem affected both travel directions. Standing water was deep enough that traffic avoided using the right travel lane in both directions between Yeager Road and Nighthawk Drive. The road elevation is generally lower than the adjacent properties in this area, and runoff from parking lots could be a primary cause of standing water on the road.

[9] Indiana Department of Transportation, Driveway Permit Manual, October 1996, Table 8-1.

No drainage problems were observed along US 52 west of Yeager Road or along US 231 (Northwestern Avenue) between Lindberg Road and US 52.

3.4 Transit and Pedestrian/Bicycle Operation

Current and planned trail facilities, shown in **Figure A8**, will allow good access to many locations within the US 52 and US 231 (Northwestern Avenue) corridors. However, within the commercial portion of the US 52 corridor between Yeager Road and Nighthawk Drive, there is limited bicycle and pedestrian accessibility, especially on the south side of the street. There is also very limited bicycle and pedestrian accessibility along the segment of US 231 (Northwestern Avenue) between Lindberg Road and US 52.

Transit accessibility to destinations in the study corridor appears to be very good, although direct access to destinations along US 52 between Salisbury and Yeager is limited. CityBus representatives cited the lack of a traffic control signal at the intersection of US 52 and Paramount Drive as having an adverse affect on their operations. Due to the difficulty of entering US 52 from this intersection, the express route to the Campus Suites location must return to campus by travelling through the Colony Pines subdivision to reach the traffic signal at Morehouse Road. CityBus has indicated that it has discussed with the County its desire for a signal at Paramount Drive.[5] As discussed previously in this report, INDOT has determined that a traffic signal is warranted at this intersection and is pursuing its construction.

A conceptual planning analysis of bicycle, pedestrian and transit LOS was performed for the study corridor using the methods of the Florida Department of Transportation Quality/Level of Service Handbook and the associated LOSPLAN software package.[10] The analysis was performed for the existing PM peak hour, and the results are shown in **Table 3-12**. The results in the table reflect that multimodal accommodation in these corridors is generally marginal to inadequate. Caution should be used in interpreting the results for the western portion of US 52, as these LOS measures were developed primarily for application in urban areas.

The LOS measures for bicycle, pedestrian and transit do not reflect the demand for these travel modes along a particular road segment, but only the availability of facilities or service along that segment. The main factor affecting Transit LOS is the number of buses in the peak direction during the peak hour. The results reflect 3 buses per hour along much of the corridor, but no buses along US 52 east of Yeager Road. The main factors affecting pedestrian LOS are the presence of sidewalk, its lateral separation from the road, and roadway traffic volumes. The main determinants of bicycle LOS are roadway traffic volumes and the presence of a paved shoulder or wide outside lane. The bicycle LOS on US 52 west of Yeager

[10] Florida Department of Transportation, Quality/Level of Service Handbook, 2009 Edition, http://www.dot.state.fl.us/planning/systems/sm/los/pdfs/2009FDOTQLOS_Handbook.pdf.

Road is reported to be a marginally acceptable "D", but should be considered to be worse. Limitations of the analysis method did not account for the fact that the paved shoulder is interrupted in many locations by intersection turn lanes and driveway deceleration lanes.

Table 3-12: Existing Pedestrian, Bicycle and Transit Levels of Service

Road Segment	Pedestrian LOS	Bicycle LOS	Transit LOS
US 52, west of Yeager	E	D	D
US 52, east of Yeager	D	E	F
US 231 (Northwestern)	E	E	D

3.5 Problem Identification Summary

This section provides a summary of the most significant problems and problem locations identified during analysis. These problems will be the primary targets for the development of improvement recommendations, although recommendations may also be developed to address other identified problems.

US 52 segment west of Yeager Road

- The rural cross section of the road (shoulders, wide depressed medians and open ditch drainage) contributes to high vehicle speeds, which are incompatible with the amount of adjacent development.
- Numerous uncontrolled driveways and median cuts contribute to vehicle conflicts and safety problems. This problem will become worse as traffic volumes and adjacent development increase.
- There are no sidewalks along US 52 west of Yeager Road. High traffic volumes and speeds discourage use by bicyclists. Paved shoulders, which would generally be used by bicyclists, have been converted to intersection turn lanes and driveway deceleration lanes at many locations.

US 52 segment east of Yeager Road

- The large number of closely-spaced driveways between Yeager Road and Nighthawk Drive contributes to crash and congestion problems, particularly in the segment between Yeager Road and Salisbury Street.
- The segment of US 52 from Sycamore Lane to Salisbury Street was identified as a high crash location. Most of the crashes occur at the locations with median cuts for driveways and appear to be caused by drivers entering US 52 with inadequate gaps. Other crashes are caused by traffic slowing on US 52 due to congestion or driveway conflicts.
- Drainage along US 52 between Yeager Road and Nighthawk Drive is inadequate to accommodate a moderately heavy rainfall event. Significant ponding of water at several locations impacted vehicle flow and reduced lane capacity. Runoff from adjacent parking areas could be a primary cause of standing water on the road.

- Because of its dense commercial nature, bicycle, pedestrian and transit accessibility should be encouraged in this area. However, accessibility is difficult due to discontinuous sidewalks, lack of bicycle facilities and no direct bus service along US 52.

Northwestern Avenue segment between Lindberg Road and US 52

- Pavement on Northwestern Avenue north of Yeager Road is in extremely poor condition and in need of resurfacing or reconstruction.
- The rural cross section of the road (shoulders, wide depressed medians and open ditch drainage) contributes to high vehicle speeds, which are incompatible with the amount of adjacent development.
- There is only one short, disconnected segment of sidewalk along Northwestern Avenue north of Lindberg Road. High vehicle speeds, poor pavement conditions and lack of continuous paved shoulders discourage use by bicyclists.

US 52 & CR 300 W (Klondike Road)

- Crash frequency at this intersection indicates that it could be a high crash location.
- Existing split-phased signal operation for the northbound and southbound CR 300 W approaches is inefficient but is used due to inadequate turn lane lengths on these approaches.
- A single westbound left turn lane on US 52 provides inadequate service for existing and projected westbound left turn volumes, although widening would be required to provide additional lanes.
- Additional capacity on the northbound CR 300 W approach will eventually be needed to accommodate left and right turn volumes.
- The cemetery on the northeast corner is within the intended horizontal obstruction-free zone for US 52 and restricts alternatives for adding capacity at this intersection.

US 52 & Relocated US 231

- Although traffic analysis did not indicate a problem, the short offset between the relocated US 231 intersection and the existing CR 250 W to be maintained north of US 52 is not a desirable design and could cause operational or safety problems.
- This intersection operates near capacity in 2030, with LOS of E or F for several movements in the PM peak hour. Demand for the westbound US 52 and southbound US 231 left turn movements exceeds the capacity of these movements.
- High westbound US 52 left turn volumes are expected to require a 2nd left turn lane to meet minimum LOS standards by 2030.

US 52 & Morehouse Road

- This intersection was identified as a possible high crash location. Vehicle speeds on US 52 may be a contributing factor. Signal visibility for eastbound vehicles on US 52 is limited due to road curvature, but it meets minimum requirements.

- Existing peak hour traffic demand exceeds capacity for several movements, including through movements on US 52. The growth in traffic volumes through 2030 will only exacerbate existing problems.
- Providing additional lane capacity at this intersection and at the US 52/Cumberland intersection could help to improve conditions corridor-wide by enabling INDOT to use shorter traffic signal cycle lengths in the corridor.

US 52 & Win Hentschel Boulevard

- Due to high volumes on US 52, the westbound left turn movement from Win Hentschel experiences excessive delay during the existing PM peak hour and during both the AM and PM peak hours in 2030.

US 52 & Cumberland Avenue

- This intersection was identified as a high crash location.
- Travel speeds on US 52 are more than 5 mph above the speed limit in the area near Cumberland Avenue and may contribute to the high number of rear end crashes on US 52 at this intersection.
- Eastbound Cumberland left turn movement and southbound US 52 through movement demand volumes currently exceed capacity in the PM peak hour.
- High volumes of eastbound left turns from Cumberland Avenue operating without a protected left turn signal phase may contribute to left turn crashes on this approach.
- Significant weaving (lane changing) occurs among northbound vehicles on US 52 between the US 231 (Northwestern Avenue) entrance ramp and Cumberland Avenue. There is no evidence that they cause crashes, but the weaving maneuvers reduce the capacity of the road segment and have been observed to cause vehicle conflicts.

US 52 & Yeager Road

- The westbound US 52 left turn movement, the northbound Yeager through movement and the southbound Yeager left turn movement all currently experience poor LOS during the PM peak. Demand is expected to exceed the capacity of these movements by 2030. Additional lane capacity will be warranted for each of these movements, but would require intersection widening.
- This intersection was identified as a potential high crash location. The westbound US 52 approach has experienced a much higher number of crashes than the other approaches, likely due to queuing on this approach during congested conditions and interference from the adjacent upstream commercial driveways. The relatively high number of westbound left turn crashes is indicative of the high left turn volumes, high travel speeds on the opposing eastbound US 52 approach and the fact that this movement operates close to its capacity.

US 52 & Salisbury Street

- Several movements, including through movements, currently experience significant delay and volumes at or exceeding capacity in the peak periods. Lack of lane capacity results in significant queuing on both US 52 approaches during the peak hours. Additional lane capacity is required on all approaches.
- This intersection currently has the worst LOS of any intersection in the study area and is expected to have the worst operation through 2030.
- This intersection was identified as a high crash location. The crash problem is likely due to congested conditions and the proximity of adjacent driveways.

US 52 & Nighthawk Drive

- Insufficient separation and storage space exists between US 52 and the frontage road on the north side, which results in queuing and conflicts.
- Eastbound US 52 through, westbound US 52 left turn and southbound Nighthawk left turn demand volumes are all expected to exceed capacity by 2030.

Northwestern Avenue & Lindberg Road

- Westbound through and eastbound left turn demand volumes on Lindberg are expected to exceed the capacity of these movements by 2030.
- Pedestrian conflicts have been observed.

4 IMPROVEMENT CONCEPTS

This chapter describes conceptual improvements that have been identified to address the US 52 Corridor transportation problems discussed in Chapter 3. Roadway improvements, such as additional vehicle travel lanes or intersection traffic control modifications, were identified through software analysis of highway capacity Level of Service using Synchro/Simtraffic analysis software. Other improvements were identified as common countermeasures to reduce speeding and crash problems, improve roadway design, or improve pedestrian and bicycle access. Candidate improvement concepts were screened and refined through multiple meetings of the study steering committee, and were presented for public input at a November 15, 2010 meeting. While the concepts identified in this study are anticipated to greatly improve transportation in the US 52 corridor, they are not expected to correct all identified problems. It is often not feasible to solve all transportation problems in a corridor, especially one where adjacent land uses are fully developed.

The remainder of Chapter 4 provides an overview of the improvement concepts developed for the study corridor and how they address the identified transportation problems. Chapter 5 describes the specific potential projects that would implement these improvement concepts and provides proposed layouts, implementation costs and right-of-way impacts.

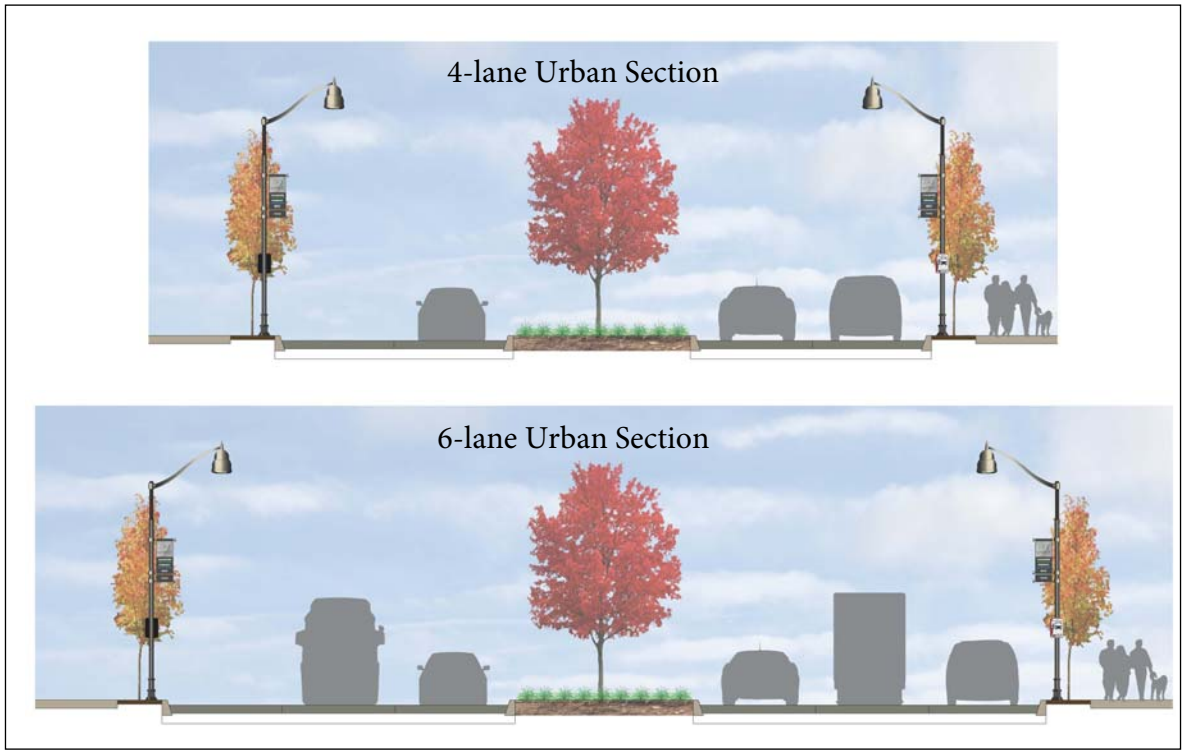
4.1 Road Improvements

4.1.1 US 52 west of Yeager Road

Urban typical section

The segment of US 52 west of Yeager Road is currently designed with paved shoulders, open drainage ditches and wide building setbacks. This design contributes to an open, rural feeling and higher vehicle speeds. This segment of US 52 has no accommodation for pedestrians and bicyclists, and high vehicle speeds discourage these alternate modes. Proposed improvements would include reconstructing US 52 from Klondike Road to Yeager Road to have an urban typical section, using curb and gutter, a raised median and enclosed drainage. Sidewalks and multi-use trails would be provided for pedestrians and cyclists, and roadway lighting would improve safety for all corridor users. The use of curb and gutter with enclosed drainage would minimize the right-of-way requirements associated with additional travel lanes, sidewalks or trails. The curb and gutter section would also tend to slow vehicular traffic, especially if appropriate roadside landscaping were used. Speed limits should be no greater than 45 mph in curbed sections. **Figure 4-1** shows typical sections for 4-lane and 6-lane urban arterials.

Figure 4-1: Typical Urban Arterial Sections



Added travel lanes between Morehouse and Northwestern

A third through lane would be provided in both the eastbound and westbound direction on US 52 from west of the Morehouse Road intersection to the Northwestern Avenue interchange. The additional through lanes are needed to help meet minimum vehicle Level of Service requirements at the Morehouse Road and Cumberland Avenue intersections and would be continuous between these intersections. The urban section would have 2 travel lanes in each direction from Klondike Road to Morehouse Road and from Northwestern Avenue to Yeager Road, and 3 travel lanes in each direction from Morehouse to Northwestern Avenue.

Intersection improvements

In addition to the added travel lanes between Morehouse Road and Northwestern Avenue, added turn lanes and traffic signal timing improvements would be required at several intersections by 2030 in order to meet minimum vehicular Level of Service requirements. These include the US 52 intersections with Klondike Road, relocated US 231, Morehouse Road and Cumberland Avenue. Per INDOT analysis, the intersection of US 52 with Paramount Drive warrants installation of a traffic signal in 2010. The US 52 intersection with Wyndham Way could warrant a traffic signal at the time that the proposed Meijer site is developed.

Northwestern Avenue entrance ramp improvements

Westbound US 52 currently experiences traffic operational problems between the Northwestern Avenue entrance ramp and the Cumberland Avenue intersection due to high traffic volumes and significant numbers of lane changes in this segment. Modifications to the horizontal and vertical alignment of the Northwestern Avenue entrance ramp would allow its merge point with US 52 to be moved farther upstream and away from Cumberland Avenue. This would provide more space for vehicle weaving maneuvers between the ramp merge and the Cumberland Avenue intersection. Preliminary analysis indicates that the merge point could be moved at least 500 feet farther upstream.

The potential benefit of extending an additional lane on westbound US 52 from the Northwestern Avenue entrance ramp to the Cumberland Avenue intersection was also evaluated. It was determined that this lane would have a traffic operations benefit if the additional lane were to extend through the Cumberland Avenue intersection, but not if it were to terminate as a left turn or right turn lane at Cumberland Avenue.

Potential future US 52/Northwestern Avenue intersection

In the long term, the US 52/ Northwestern Avenue interchange could be replaced by an at-grade intersection. This would have little impact on traffic operation at this location, but it could improve traffic operation at the US 52/Yeager Road intersection. It would also help to reduce traffic speeds along this section of US 52. This improvement should be considered for implementation when the bridge that carries Northwestern Avenue over US 52 needs to be replaced or requires major rehabilitation, as it could be a lower cost alternative. The at-grade intersection could operate with either a traffic signal or a 2-lane roundabout. In either case, westbound US 52 traffic coming from Yeager Road would be allowed to bypass the intersection without stopping. Eastbound US 52 traffic destined for southbound Northwestern Avenue would also be able to proceed without stopping. Eastbound US 52 traffic traveling toward Yeager Road and northbound traffic on Northwestern Avenue would need to go through the intersection. A northbound to eastbound right turn movement and a westbound to southbound left turn movement are not provided by the existing interchange, but could be allowed if converted to an intersection. This could be combined with the prohibition of westbound left turns at the intersection of US 52 with Yeager Road in order to improve the operation of that intersection.

As an alternative to the US 52/Northwestern Avenue at-grade intersection, the direct connection between US 52 and Northwestern Avenue could be completely eliminated. Under this alternative, all traffic would be routed along Yeager Road to connect between US 52 and Northwestern Avenue. This would require additional improvements at the intersections of Yeager Road with US 52 and with Northwestern Avenue and could require additional improvements along Yeager Road as well.

An additional benefit of removing the US 52/Northwestern Avenue grade separation could be realized by realigning the eastbound and westbound US 52 roadways between Cumberland Avenue and Yeager Road. The existing large median area would no longer be required to accommodate the entrance ramp from Northwestern Avenue. The eastbound roadway could be relocated closer to the existing westbound roadway in order to make several acres of land available for other use.

Traffic control for rural to urban transition

The traffic signal at Klondike Road is the first signal encountered by eastbound US 52 drivers as they transition from a high-speed rural environment to a lower-speed urban environment. A large number of the crashes at this intersection involve westbound vehicles turning left in front of eastbound vehicles, and it is thought that the speed of eastbound traffic contributes to the high number and severity of these crashes. While there is a "Signal Ahead" warning sign for eastbound traffic approaching Klondike Road, providing a more visible warning should help to increase drivers' awareness of upcoming traffic conditions. This could be accomplished by adding flashers to the Signal Ahead warning sign. In the long term, other improvements like gateway enhancements (see **Section 4.3**) and reconstruction of the road to an urban typical section will also help to slow speeds through this area.

Parallel road capacity

West of Morehouse Road, good alternate routes within a mile of US 52 do not exist. As development continues in this area, the use of US 52 for local access will grow and will impact the ability of the highway to carry through traffic. The need for alternate routes to divert local access from US 52 should be considered before land development makes their construction infeasible. The costs and benefits of such roads were not evaluated in this study, but could be investigated as part of a future regional transportation plan update.

4.1.2 US 52 East of Yeager Road

The segment of US 52 east of Yeager Road currently experiences high crash rates and daily congestion problems. In order to improve traffic operation, additional road capacity is needed both on US 52 and on key cross streets. However, the narrow right-of-way and dense existing development along this segment of US 52 mean that adding capacity could have significant impacts. Even the addition of adequate bicycle and pedestrian facilities with no roadway widening would have impacts to adjacent commercial properties.

Because of the anticipated costs and significant impacts of adding travel lanes to US 52 between Yeager and Nighthawk, alternative concepts were considered for improving traffic operation in this segment. The base concept is to improve vehicle traffic operation by adding travel lanes to US 52 along the entire segment. A second alternative concept is to maintain the existing 4-lane US 52 roadway but improve operation at intersections by moving left turns to a series of newly-constructed median u-turn intersections. A third alternative concept combines widening at the Yeager and Nighthawk intersections with an alternate intersection

configuration called a "quadrant roadway intersection" at Salisbury Street. These concepts are explained below, and a summary table of the advantages and disadvantages of each of these three alternative improvement concepts is provided at the end of the section.

Added lanes alternative

The first alternative improvement concept is to reconstruct and widen the entire segment of US 52 between Yeager Road and Nighthawk Drive to add a third through travel lane in each direction. The road would have a typical section similar to the 6-lane section proposed between Morehouse and Cumberland, as shown in **Figure 4-1**. The center median would be widened to provide a better refuge for pedestrians crossing US 52, and continuous sidewalk and/or trail facilities would be constructed along both sides of US 52. Reconstruction of the road would address existing pavement conditions, and reconstruction of the drainage system would resolve existing ponding problems. Additional through lanes and turn lanes would also need to be added at the Yeager Road, Salisbury Street and Nighthawk Drive intersections in order to meet minimum vehicle Level of Service requirements.

Median u-turn corridor alternative

The second alternative improvement concept is to prohibit all left turn movements at the Yeager Road, Salisbury Street and Nighthawk Drive intersections and construct a series of five new median u-turn intersections along US 52 to accommodate these turn movements. **Figure 4-2** shows the configuration of a typical arterial intersection where left turns have been prohibited and are accommodated at adjacent median u-turn intersections. **Figure 4-3** shows the example paths of a vehicle turning left from the arterial (green path) and from the cross street (red path).

Figure 4-2: Typical Median U-Turn Configuration

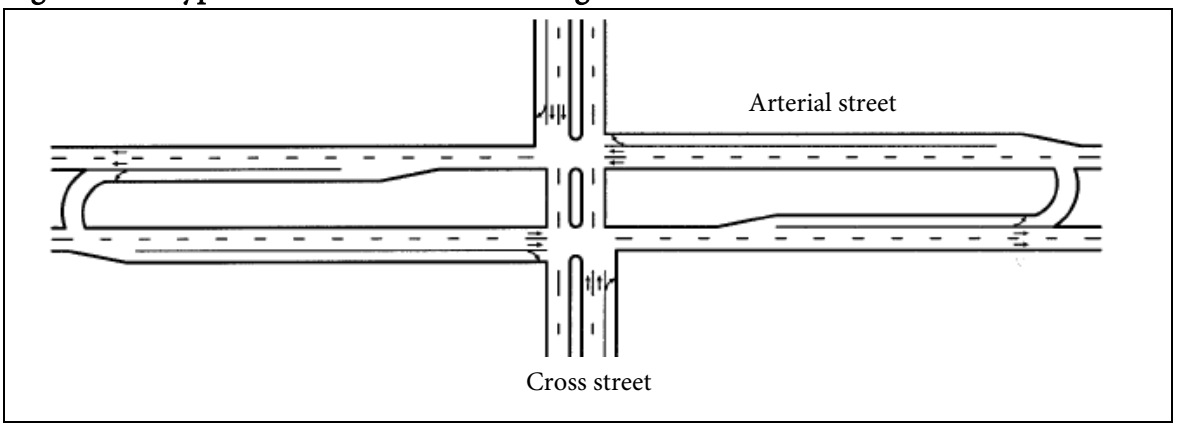
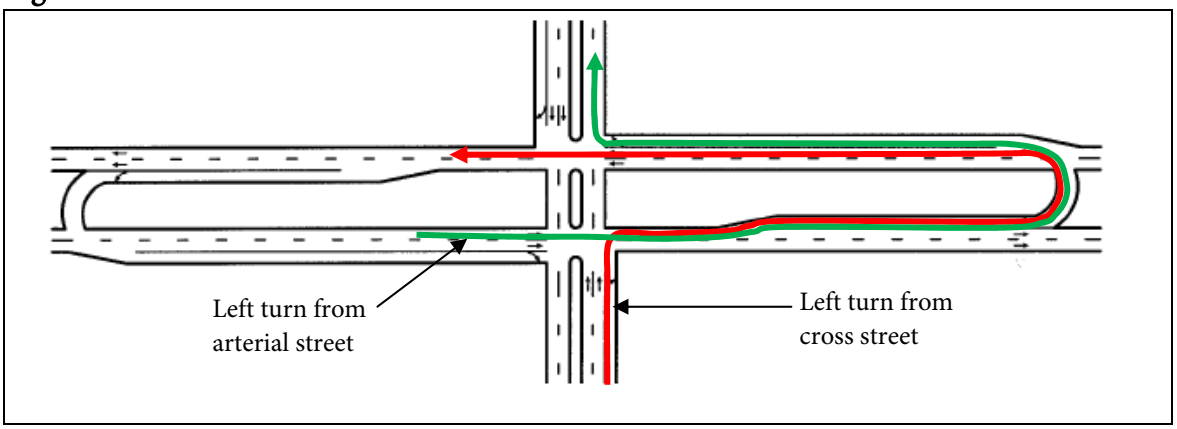


Figure 4-3: Left Turn Movements at a Median U-Turn Intersection



The implementation of median u-turn intersections would result in traffic flow and safety improvements on US 52 without the need to add a third through lane in each direction. This is due to the elimination of left turn movements at the primary cross street intersections of Yeager Road, Salisbury Street and Nighthawk Drive, along with the signal time required to accommodate these movements. Due to traffic volumes and vehicle speeds, it is recommended that all median u-turn intersections on US 52 be controlled by traffic signals. These intersections would be located approximately 660 feet from the primary cross street intersections in order to provide good vehicle progression through the traffic signals on US 52, although the exact separation distance is somewhat flexible. Although additional travel lanes would not be added under this alternative, the road would be entirely reconstructed in order to improve existing pavement and drainage conditions.

Median u-turn intersection treatments are usually implemented on arterials with wide medians because of the space required for vehicles to execute a u-turn. Where the median is of insufficient width, additional pavement must be added to the outside of the roadway in order to accommodate the turning path of the large tractor-trailer trucks that use US 52. **Figure 4-4** shows an example of this pavement widening from 44th Street SE in Grand Rapids, Michigan. Widening such as this would be required at the median u-turn intersections along US 52 because the existing 16-foot median width will not allow the design vehicle (a WB-50 truck) to execute a u-turn without encroaching on the curb. The right-of-way impact of widening for the u-turns is one drawback to the median u-turn concept on US 52. The potential for driver confusion and the additional travel required for vehicles to make left turns are other drawbacks.

Providing new intersections specifically to accommodate u-turn movements along US 52 could also eliminate the need for permitting left turns onto US 52 from driveways or minor side streets, which would improve safety and reduce delay.

Figure 4-4: Example Widening at Narrow Median U-Turn Intersection

Quadrant roadway intersection alternative

The third alternative roadway improvement concept for the Yeager to Nighthawk segment of US 52 is to prohibit all left turn movements at the intersection of US 52 and Salisbury Street and construct a quadrant roadway to accommodate these turns. **Figure 4-5** shows a conceptual layout for a typical quadrant roadway intersection, and **Figure 4-6** shows how turns are accommodated at this type of intersection. This configuration would greatly improve operation at the US 52/Salisbury Street intersection by providing more through traffic capacity and moving left turns to alternate locations. The drawbacks of this concept are the right-of-way required to accommodate the quadrant roadway, the potential for driver confusion, and the additional out-of-the-way travel required by drivers making left turns.

Implementation of a quadrant roadway intersection at US 52 and Salisbury Street would not resolve the capacity problems at the Yeager and Nighthawk intersections. Additional US 52 through lanes would still be required at those intersections in order to meet minimum Level of Service requirements. Pavement and drainage would need to be reconstructed throughout the segment in order to address existing problems.

Figure 4-5: Typical Quadrant Roadway Intersection Configuration

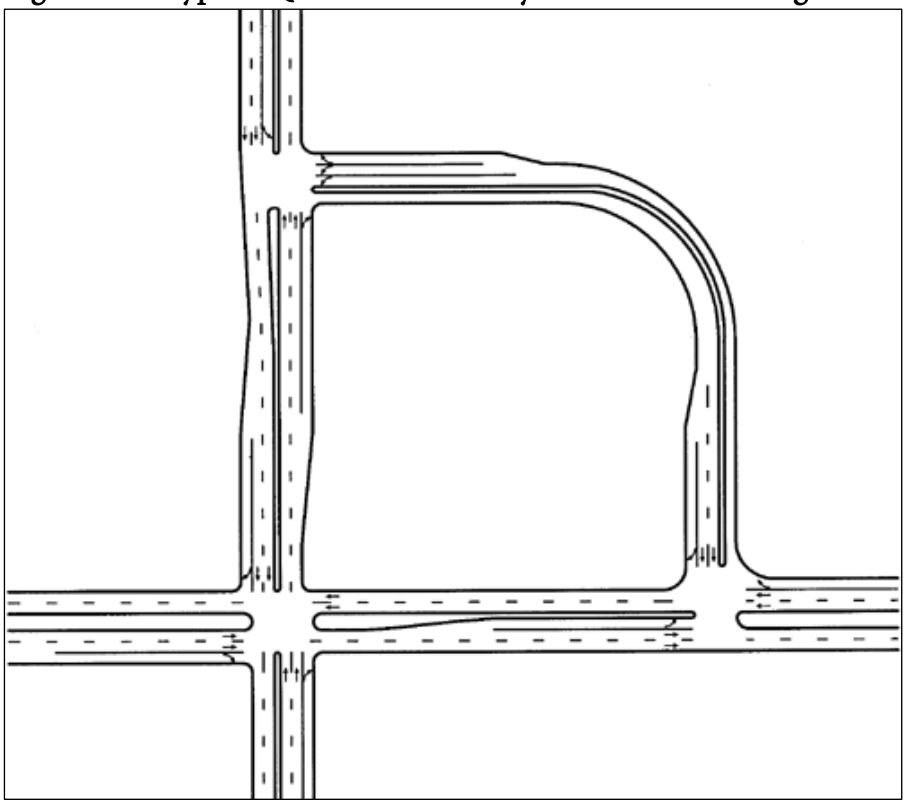


Figure 4-6: Left Turn Movements at Quadrant Roadway Intersections

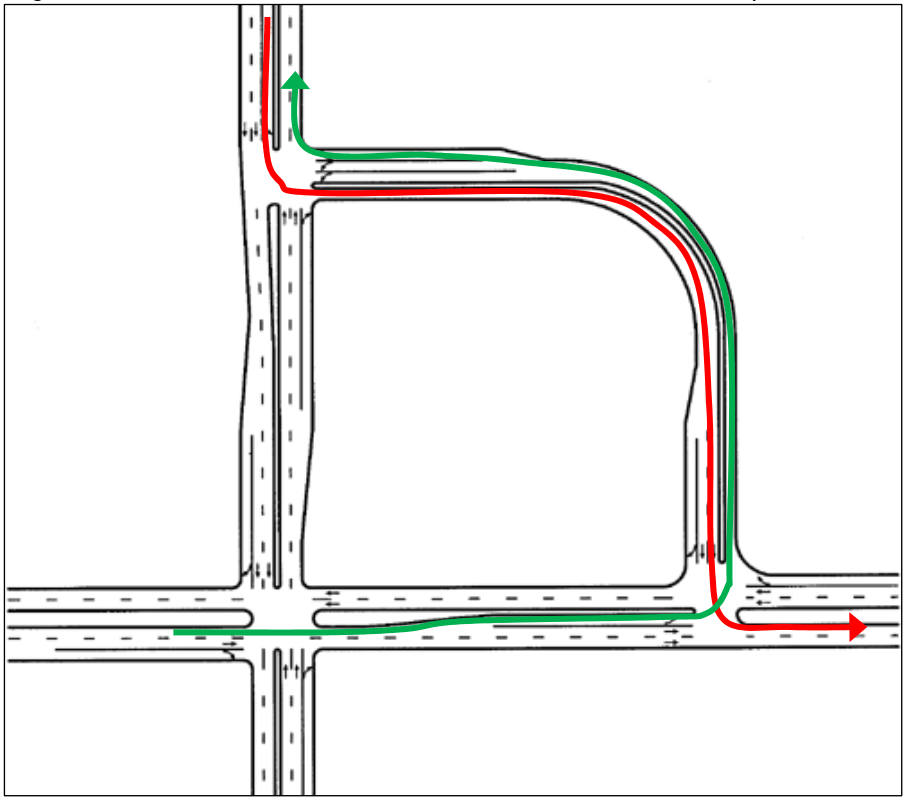


Table 4-1: Comparison of Yeager to Nighthawk Alternative Improvement Concepts

Alternative	Advantages	Disadvantages
Widen to 6 through lanes	• Easy for drivers to understand • Provides more capacity between intersections to help driveway movements	• Significant right-of-way impacts along entire segment • Still some delay at Salisbury • Wide intersections at pedestrian crossings
Implement median u-turn corridor	• Better intersection operation than widening • Fewer impacted properties along the Yeager to Nighthawk segment than 6-lane widening • Best alternative for pedestrians crossing US 52 • Could restrict left turns from driveways to improve safety with little traffic operation impact	• Could be confusing for unfamiliar drivers • Left turns are indirect • Significant right-of-way impacts and paving at u-turn locations
Construct quadrant roadway intersection at US 52 & Salisbury	• Better vehicle operation at Salisbury than widening • Fewer impacted properties along the Yeager to Nighthawk segment than 6-lane widening	• Significant right-of-way impacts at Salisbury intersection • Still requires widening at Yeager and Nighthawk • Could be confusing for unfamiliar drivers • Left turns are indirect at Salisbury

Alternate commercial access

As the commercial area between Yeager and Nighthawk redevelops over time, a more robust network of parallel roads could help to move commercial access off of US 52 and thus provide more capacity for through traffic movement. Two-way roads could be constructed parallel to US 52 on both the north and south sides to provide access to the commercial areas between Yeager Road and Nighthawk Drive. **Figure A-13** is a concept plan showing the location of the potential commercial access roads. Their construction would ideally be combined with limitations on direct driveway access from US 52. In this case, all traffic would only enter or leave US 52 only at signalized intersections with Yeager Road, Salisbury Street, Nighthawk Drive, and possibly a new road halfway between Salisbury Street and Yeager Road. All access to adjacent property would be from the parallel access roads. It is also possible that limited number of right-in, right-out driveways could be maintained on US 52.

Portions of a parallel access road system already exist, and these could be extended and connected as property in the US 52 corridor is redeveloped. Access roads could either be

frontage roads located between US 52 and adjacent development or "backage" roads on the far side of the development. In either case, separation between US 52 and the parallel access roads should be at least 300 feet at their cross-street intersections, but may be limited by existing residential development in some cases. The minimum acceptable separation is 150 feet. If backage roads or rear parking are used in redevelopment, appropriate screening of adjacent residential areas should be required.

The existing frontage road on the north side of US 52 from Covington Street to Nighthawk Drive could be retained, but its intersections with these streets would need to be moved farther away from US 52. In addition, the access between US 52 and the frontage road that exists between Covington Street and Nighthawk Drive should be eliminated.

Implementation of parallel access roads in this segment of the US 52 corridor would require a coordinated development plan to be successful. This approach could contribute to efforts to redevelop this area as a more livable and walkable commercial area. It is recommended that this concept be considered for future implementation, but no specific projects were identified for this study.

Traffic control for speed reduction

Spot speed data show that westbound vehicles do not slow down sufficiently as they approach the study area from the Wabash River crossing and that they travel at an average of 1.5 to 3.5 mph faster than eastbound vehicles through the Yeager to Nighthawk segment of US 52. The speed limit for westbound traffic is reduced from 55 mph to 40 mph within a distance of less than ½ mile approaching Nighthawk Drive, and improving drivers' awareness of this reduction could help to slow westbound traffic speeds. Two immediate signing changes would help improve the awareness of drivers. First, the 40 mph speed limit sign just east of Nighthawk should be made more visible, as its current location can be obscured by foliage. Second, a "Reduced Speed Limit Ahead" sign (W3-5) placed along westbound US 52 between Soldiers Home Road and Nighthawk Drive would help to warn drivers of the reduction to 40 mph. In the long term, landscaping and other gateway enhancement features located along US 52 in the vicinity of Soldiers Home Road would also help to slow westbound traffic entering West Lafayette. These enhancements are described in **Section 4.3**.

4.1.3 Northwestern Avenue

Urban typical section

Like US 52 west of Yeager Road, the segment of Northwestern Avenue from Lindberg Road to US 52 is predominantly designed with shoulders and open drainage, and has poor accommodations for pedestrians and cyclists. This segment of Northwestern Avenue would be reconstructed as a 4-lane urban arterial (as shown in **Figure 4-1**) with curb and gutter, sidewalk and trail facilities, a raised median and enclosed drainage. This reconstruction would also resolve the poor pavement condition that exists between Yeager Road and US 52.

As discussed previously in this chapter, replacement of the US 52/Northwestern Avenue interchange with an at-grade intersection could be beneficial in the long term. This would require realignment of Northwestern Avenue between US 52 and Neil Armstrong Drive.

Intersection improvements

The intersection of Northwestern Avenue and Yeager Road is scheduled to be reconstructed as a 2-lane roundabout, which should provide acceptable traffic operation through 2030. The intersection of Northwestern with Lindberg Road, however, would require additional approach lanes by 2030 in order to meet vehicle Level of Service standards. An additional eastbound and westbound through lane would be required on Lindberg Road and an additional northbound right turn lane would be required on Northwestern Avenue. These additional lanes would impact residential properties adjacent to the intersection. A roundabout was evaluated for this intersection, but was not found to be an appropriate solution for forecast travel demand. A 3-lane roundabout would be required to prevent unacceptable traffic queuing on Northwestern Avenue during the peak hours of the day, and a roundabout of this size would have significant impacts on adjacent property.

4.2 Bicycle and pedestrian facilities

Enhancement of the sidewalk and trail network in the US 52 and Northwestern Avenue corridors would improve accessibility and safety for pedestrians and cyclists, encourage the use of these modes as an alternative to automobile travel, and improve accessibility to transit. Proposed sidewalk and trail connections beyond those identified in current plans have been identified in this study and are shown as dotted lines in **Figure A-14**. The green dotted lines indicate proposed segments of new sidewalk, and the red dotted lines indicate segments of new shared-use pedestrian and bicycle trail. The shared-use trails would be 2-way facilities with a minimum width of 10 feet.

Trail or sidewalk facilities are proposed on both sides of US 52 and Northwestern Avenue to provide access to adjacent property and transit service. Crossing locations at major intersections would be designed to safely accommodate pedestrians and cyclists, including crosswalks, pedestrian signal indications and median refuge areas. The construction of new sidewalk and trail facilities located adjacent to US 52 or Northwestern Avenue should be included with road improvements, and these new facilities should be connected to nearby existing facilities. Road projects should also bring any existing sidewalk and trail facilities into compliance with the Americans with Disabilities Act. In some locations, separate facilities located outside of the US 52 right-of-way could provide better access to destinations in the corridor, and construction of these facilities should be pursued as development opportunities allow.

Grade separated pedestrian and bicycle overpasses are not proposed as part of this study. These structures are very expensive and, according to the National Pedestrian and Bicycle Information Center, should be constructed as a last resort[11]. They must accommodate disabled users, which often requires the use of elevators or extensive ramp systems. This may result in long crossing distances and times that discourage the use of the grade separations. Studies have shown that grade separated crossings are not well-used unless they allow for a faster crossing. It is recommended that resources be focused on improving at-grade pedestrian and bicycle crossings.

4.3 Gateway enhancements

Gateway enhancements are signature design elements that would be positioned at specific locations within the US 52 corridor to provide valuable information for travelers, contribute to a unique overall character for the corridor, and help to calm traffic. Gateway enhancements would be designed to offer distinctive monumental entrances at key intersections along the US 52 Corridor. Enhancements could incorporate structural elements, wayfinding signage and graphic information, pedestrian provisions (e.g., benches, drinking fountains or sun shelters), landscape treatments, lighting and low-impact stormwater treatment.

The proposed locations for gateway enhancements are shown in **Figure A-15**. Primary gateway enhancements would be located near the US 52/Klondike Road intersection and near the Soldiers Home Road interchange, where development patterns and road design will transition from rural to urban. These gateways would help drivers to realize that they are entering the urban area and need to reduce their speed. Secondary gateway enhancements would be placed at other important locations through the corridor to reaffirm the corridor theme, provide additional information and help to calm traffic on US 52. The intersections of US 52 with relocated US 231, Cumberland Avenue and Salisbury Street are recommended locations for secondary gateways. A secondary gateway is also recommended for the intersection of Northwestern Avenue and Yeager Road. A unified design theme would be used for all enhancements throughout the corridor.

This study provides recommendations for enhancement focus areas, but does not identify specific enhancement themes, design elements or project costs. Future planning efforts should further define the desired level of treatment, design themes and funding commitment for enhancement projects in the corridor. Enhancement themes could draw on the unique features of the corridor, such as its vital connections to the Purdue Research Park, the Celery Bog, and West Lafayette's commercial businesses.

[11] National Pedestrian and Bicycle Information Center, *Pedestrian Overpasses/Underpasses*, web document available at http://www.walkinginfo.org/engineering/crossings-overpasses.cfm

4.4 Access Management

The numerous private driveways along US 52 between Yeager Road and Nighthawk drive have a negative impact on traffic flow and safety. Vehicles slowing to enter a driveway or exiting from a driveway can slow or block through traffic on the road. Vehicles entering or exiting driveways must wait for gaps to cross traffic, which is especially difficult when traffic volumes are heavy or vehicles must cross multiple travel lanes. The crash problems that result from this can be seen in Table 3-8. While existing driveways on US 52 west of Yeager Road do not yet have as much impact, the problems caused by traffic at these drives and at existing median crossovers will increase with continued development. Driveway permitting requirements and roadway design projects should apply "access management" standards to limit or reverse the negative impacts of property access on US 52 traffic flow and safety.

Access management involves controlling the design and location of access to the highway system in order to maintain the appropriate balance between the traffic movement and land access functions of a road. Access management techniques include ensuring adequate spacing of intersections and driveways, the use of auxiliary lanes to separate through and turning traffic, the use of medians and turn restrictions to limit uncontrolled highway access, and the proper design of driveway and site circulation to minimize interference between site traffic and highway traffic.

INDOT has developed an *Access Management Guide*[12] to describe the specific objectives, techniques and criteria for access management on state and local highways in Indiana. US 52 within the area of this study is classified as a Regional Corridor according to INDOT's guidelines. As such, its primary function should be maintaining through traffic movement, with a secondary function of providing direct property access. The INDOT guidelines for a Regional Corridor should be followed during reconstruction of US 52 and approval of new or revised development access. These guidelines include, but are not limited to, the following:

- Ideal spacing of at least ½ mile between signalized intersections, with ¼ mile spacing acceptable where the speed limit is 40 mph or less
- Traffic progression that provides at least 40% of the traffic signal green time to US 52 at any signal that cannot meet the ideal spacing requirement
- Full-movement access allowed at public road intersections and major commercial driveways only, with minor driveways restricted to right-in, right-out only
- Spacing and location restrictions for access driveways per the requirements of the INDOT *Driveway Permit Manual*
    - Access limited to a single drive per property unless frontage exceeds 400 feet

[12] Indiana Department of Transportation, *Access Management Guide*, September 2009 revision, available at http://www.in.gov/indot/files/guide_total.pdf

  - Driveways prohibited within the functional limits of an intersection, which includes all turning bays and driver perception-reaction distance upstream of those bays
  - Driveways prohibited from being any closer to signalized intersections than the average signal queue length
  - Spacing of at least 300 feet between adjacent driveway where the speed limit is 40 mph and at least 350 feet where the speed limit is 45 mph (longer for higher speeds)
  - Minimum spacing between driveways and property lines of at least 90 feet where the speed limit is 40 mph and 115 feet where the speed limit is 45 mph (longer for higher speeds)
- Location and functional requirements for median crossovers per the requirements of the INDOT *Driveway Permit Manual*
  - Spacing of at least 400 feet from other crossovers or intersections
  - Location allows sufficient room for auxiliary lanes and recovery tapers
  - Traffic safety benefits of the crossover can be demonstrated

It is generally easier to implement access management when adjacent land is not yet densely developed and access points are relatively few. It is harder when the corridor is fully developed. Impacts to adjacent properties especially limit the feasibility of some solutions to manage access between Yeager Road and Nighthawk Drive. However, redevelopment and road reconstruction projects in the US 52 corridor will provide opportunities to correct existing access deficiencies and mitigate future problems. Construction of an urban cross section with a raised center median would help to minimize future access problems west of Yeager Road. Existing median crossovers should be consolidated or eliminated as much as possible, and new crossovers approved only where necessary. Consideration should also be given to closing some existing driveways throughout the corridor and consolidating access to adjacent existing driveways or new shared access drives constructed on a joint easement between adjacent properties. Priority should be given to combining multiple adjacent driveways to a single parcel and to eliminating driveways that do not meet INDOT driveway spacing or intersection corner clearance standards.

Figure A-16 shows areas of potential driveway and crossover consolidation along US 52. Specific driveways and crossovers have not been identified for closure, but consolidation to conform with the INDOT *Driveway Permit Manual* should be considered during the design of US 52 road improvements and during the approval process for new developments adjacent to US 52.

4.5 Impacts of Potential Improvements

Table 4-2 provides a qualitative summary of how the potential improvements described in this chapter address the corridor problems identified in Chapter 3. In some cases, improvements that address one problem may actually exacerbate other problems. For instance, adding traffic lanes in order to improve vehicle operation can make it more difficult for pedestrians to cross the road. Added travel lanes can also result in higher vehicle travel speeds. None of the improvement concepts west of Yeager Road are shown to have a significant impact on drainage or pavement conditions. This is because pavement and roadway drainage are currently adequate west of Yeager Road and the proposed improvements would not result in significant changes. Any increased stormwater runoff due to road construction projects would be accommodated with additional storage.

In addition to the corridor problems identified in Chapter 3, livability has been added as a performance measure for assessing corridor improvement concepts. Using transportation to enhance the broader livability goals of a community is an important idea that has often been overlooked in the past. Transportation investments can help to support community livability by:

- Providing safe and reliable transportation choices to decrease the cost, the energy requirements and the negative environmental impacts of transportation systems.
- Providing improved connectivity between homes, employment, shopping, educational opportunities and basic human services
- Providing equal access for all users
- Supporting efficient public investment and the vitality of communities through transit oriented, mixed-use development and land recycling
- Supporting healthy, safe, and walkable neighborhoods and commercial areas.

Table 4-2: Impact of US 52 Improvement Concepts on Corridor Problems

Improvement Concepts	Performance								
	Traffic Safety	Vehicle Operation	Speed Reduction	Bicycle Access	Pedestrian Access	Transit Operation	Pavement Condition	Roadway Drainage	Livability
US 52 - CR 300 W to Morehouse Road									
Construct urban section with curb, gutter and median*	■		■						■
Add turn lanes at Klondike intersection	■	■		■	■	■			■
Add turn lanes at Future US 231 intersection	■	■		■	■	■			■
Install traffic signal - Paramount Drive intersection	■	■	■	■	■	■			
Consolidate driveways	■	■		■	■				■
Improve bicycle/pedestrian facilities	■			■	■	■			■
Construct gateway enhancements at CR 300 W, US 231	■		■	■	■				■
Construct parallel roads	■	■		■	■				
US 52 - Morehouse Road to Yeager Road									
Add US 52 through lanes - Morehouse to Northwestern	■	■	■	■	■	■			
Construct urban section with curb, gutter and median*	■		■						■
Add turn lanes at Morehouse intersection	■	■		■	■	■			■
Add turn lanes at Cumberland intersection	■	■		■	■	■			■
Modify merge from Northwestern	■	■	■			■			
Replace Northwestern interchange with at-grade intersection	■		■	■	■				■
Consolidate driveways	■	■		■	■				■
Construct gateway enhancements at Cumberland			■	■	■				■
Improve bicycle/pedestrian facilities	■			■	■	■			■
US 52 - Yeager Road to Nighthawk Drive									
Add through and turn lanes - Yeager to Nighthawk	■	■	■	■	■	■	■	■	■
Construct median u-turn corridor - Yeager to Nighthawk	■	■				■	■	■	
Construct quadrant intersection at Salisbury, widen remainder	■	■		■	■	■	■	■	■
Provide alternate commercial accesss, Yeager to Nighthawk	■	■	■	■	■				■
Consolidate driveways	■	■		■	■			■	
Improve bicycle/pedestrian facilities	■			■	■	■			■
Construct gateway enhancements at Soldiers Home, Salisbury			■		■				■
Northwestern Avenue - Lindberg Road to US 52									
Construct urban section with curb, gutter and median*	■		■				■		■
Add lanes at Lindberg intersection	■	■		■	■	■			■
Improve bicycle/pedestrian facilities	■			■	■	■			■
Construct gateway enhancements at Yeager			■		■				■

*Bicycle/pedestrian improvements listed separately from urban section.

■ Improves
■ Minimal effect
■ Worsens

4.6 Public Input

A public meeting was held on November 15, 2010 to describe the improvement concepts under consideration for the US 52 and Northwestern Avenue corridors and to obtain input from the public and elected officials. Graphics available at the meeting showed potential layouts and right-of-way impacts of the improvement concepts. Cost information had not yet been developed. Comment forms were provided at the meeting and comments were also received via e-mail and through the Area Plan Commission's website. The following is a summary of comments received regarding the proposed improvement concepts. Feedback received from the public meeting was used to help refine the improvement concepts and was considered during evaluation of project alternatives.

- US 52 from Klondike to Morehouse
  Comments indicated general support for the proposed urban cross section. A few people expressed concern about limiting access to individual properties, although others commented about the dangerous conditions at numerous uncontrolled drives. There was also support for improvements to the US 52/Klondike Road intersection.
- US 52 from Morehouse to Northwestern
  A majority of comments support the proposed 6-lane urban section in this roadway segment. One comment questioned the need for 6 lanes.
- US 52 from Yeager to Nighthawk:
  Most comments acknowledged the need to make improvements to this roadway segment, but there was no clear consensus regarding which alternative concept is the best. Some were concerned with the impacts of added travel lanes on adjacent property and tended to favor the median u-turn concept. Others were concerned with potential confusion caused by the median u-turn configuration and tended to favor the added travel lanes. Constructing a quadrant intersection at US 52 and Salisbury Street was the least favored concept due to concerns about driver confusion and impacts to businesses at the intersection.
- Northwestern Avenue from Lindberg to US 52
  A majority of comments supported the proposed 4-lane urban section in this roadway segment. One comment noted minimal problems with the current arrangement.
- Pedestrian and Bicycle Facilities
  There was strong support for improving pedestrian and bicycle facilities throughout the corridor. Multiple comments cited the need for improved crossings of US 52 and Northwestern Avenue. Specific areas that were mentioned as needing trails included Northwestern Avenue and US 52 from Lindberg to Cumberland, along US 52 to the residential areas west of Morehouse Road, and along the south side of US 52 between Northwestern and Sycamore.
- Other Comments
  Several comments supported lowering traffic speeds within the corridor. The need for drainage improvements east of Yeager Road was acknowledged, and a few comments

cited a desire for "green" infrastructure such as bioswales and permeable pavement. One commenter was concerned with potential visual restrictions caused by median landscaping.

5 PROPSED PROJECTS

Conceptual layouts were developed for improvement concepts described in Chapter 4 of this report in order to determine specific costs, benefits and impacts. The improvements were grouped into discrete projects based on location and implementation phasing considerations. Planning-level cost estimates were developed for each project based on the roadway typical sections and anticipated major cost items. Right-of-way acquisition requirements were estimated by assuming a typical right-of-way setback of 10 feet behind the curb or sidewalk in areas with enclosed drainage.

The sections below describe the specific components of each potential project. **Figures A17 through A25** show conceptual layouts, intersection lane configurations, traffic control and resulting 2030 vehicle Levels of Service for the study corridor roads with these proposed projects in place. For the segment of US 52 between Yeager Road and Nighthawk Drive, three alternate conceptual layouts were developed in order to evaluate the benefits and impacts of adding travel lanes, implementing a median u-turn corridor, or constructing a quadrant roadway intersection at the US 52/Salisbury intersection. Section 5.3 describes each of the three alternatives and identifies the median u-turn corridor as the preferred option.

5.1 US 52 from CR 500 W to Morehouse Road

5.1.1 Reconstruct US 52 as 4-lane urban arterial

The segment of US 52 from Klondike Road to approximately 700 feet west of Morehouse Road would be reconstructed to a 4-lane urban typical section with curb and gutter, sidewalk/trails, a raised median and enclosed drainage. Two travel lanes would be maintained in each direction, and the raised median would allow for control of access. The speed limit of US 52 would be reduced to 45 mph within the curbed section. The flashing "Signal Ahead" beacon installed under a separate project (Section 5.1.556) would help provide warning of the reduced speed to eastbound vehicles approaching the Klondike Road intersection. The layout of this road segment is shown in **Figures A17-1** through **A17-3**. This project does not include the added turn lanes at Klondike Road, US 231, and Morehouse Road, which are included in separate projects and described later.

5.1.2 Add lanes at US 52/Klondike Road intersection

A northbound right turn lane would be added on Klondike Road. The existing northbound and southbound left turn lanes would also be lengthened. Lengthening the left turn lanes would allow the traffic signal to be retimed for concurrent northbound and southbound movement, which would further reduce delays. These improvements could be made without acquiring right-of-way from the cemetery on the northeast corner of the intersection. The proposed layout is shown in **Figure A17-1**. This project is described separately from the US

52 urban arterial reconstruction because it can be implemented prior to that project in order to address existing problems at the intersection.

5.1.3 Realign CR 250 W north of US 52

A temporary realignment of the segment of CR 250 W that is north of US 52 would be constructed so that it would become the north leg of the US 52/US 231 intersection. The existing intersection of US 52 and CR 250 W would be closed. INDOT should include this temporary alignment in its initial construction of the US 52/US 231 intersection. At the time that US 231 is extended north of US 52, the connection from US 231 to CR 250 W should be relocated to align with the proposed driveway from the Meijer site onto US 231. A conceptual layout of the temporary CR 250 W realignment is shown in **Figure A25**.

5.1.4 Add turn lanes at the planned US 52/US 231 intersection

If US 231 is extended north of US 52, then the design currently proposed by INDOT will not be adequate to meet minimum vehicle Level of Service standards for 2030 traffic. The intersection would require double left-turn lanes for northbound, southbound and westbound traffic. Initial design of US 231 south of US 52 should account for this future lane configuration, and the additional lanes should be constructed at the time that US 231 is extended north of US 52. This ultimate project would modify the interim US 52/US 231/CR 250 W intersection design described above to add a second left turn lane on the westbound, northbound and southbound approaches. These intersection turn lane improvements are describe separately from the US 52 reconstruction project because they do not have to be constructed at same time as the US 52 reconstruction. They would need to be in place at the time that US 231 is extended north of US 52, and it is anticipated that their construction would be included in the US 231 extension project. The ultimate configuration of this intersection is shown in **Figure A17-2**.

5.1.5 Install a flashing beacon signal ahead warning sign on US 52 at Klondike Road

A flashing beacon "Signal Ahead" warning sign would be installed on eastbound US 52 in advance of Klondike Road in order to provide a more visible warning of the traffic signal at this intersection. The addition of the flashing beacon should help to make eastbound drivers more aware of the traffic signal and potentially congested conditions ahead as they transition into the urbanized area. This could reduce the numerous crashes at the US 52/Klondike intersection involving eastbound vehicles.

5.1.6 Install traffic signal at the US 52/Paramount Drive intersection

A traffic signal is currently warranted at this intersection, according to INDOT analysis. This signal would reduce delay for side street traffic, including buses. It would also reduce the potential for right angle crashes. Closer spacing of signals along US 52 could also help to control speeds. Installation of this signal will be privately funded due to an agreement

between INDOT and the Paramount site developer. A cost estimate has not been developed for this project.

5.1.7 Install traffic signal at the US 52/Wyndham Way intersection

A traffic signal could be warranted at this intersection by 2015 if the Meijer-Menards site is developed further. If warranted, installation of this signal would be privately funded due to an agreement between INDOT and Menards. A cost estimate has not been developed for this project.

5.2 US 52 from Morehouse to Yeager

5.2.1 Reconstruct US 52 as a 6-lane urban arterial from Morehouse Road to Northwestern Avenue

The segment of US 52 from approximately 700 feet west of Morehouse Road to the Northwestern Avenue interchange ramps would be reconstructed to an urban typical section with curb and gutter, a raised median, enclosed drainage and sidewalk/trails. A third through lane would be provided in both the eastbound and westbound direction of US 52. A portion of this segment currently has a speed limit of 50 mph, which would need to be reduced to a maximum of 45 mph. This project does not include the addition of turn lanes at Morehouse Road, and Cumberland Avenue, as well as modifications to the US 52/Northwestern Avenue interchange. All of these are included as separate projects and are described separately. The proposed layout of this road segment is shown in **Figures A17-3** through **A17-5**.

5.2.2 Reconstruct US 52 as a 4-lane urban arterial from Northwestern Avenue to Yeager Road

The segment of US 52 from the Northwestern Avenue interchange ramps to approximately 700 feet west of Yeager Road would be reconstructed to an urban typical section with curb and gutter, a raised median, enclosed drainage and sidewalk/trails. The existing two through lanes would be maintained in both the eastbound and westbound direction of US 52. This project does not include the addition of turn lanes at Yeager Road, as well as modifications to the US 52/Northwestern Avenue interchange, which are described as separate projects. The proposed layout of this road segment is shown in **Figures A17-5** and **A17-6**.

5.2.3 Add lanes at the US 52/Morehouse Road intersection

In addition to the new through lanes on US 52, which are discussed separately, this intersection would need other new approach lanes in order to meet vehicle Level of Service criteria in 2030. A third lane would be added on the southbound Morehouse Road approach, enabling this approach to have two left turn lanes and a right turn lane. A second eastbound left turn lane would also be added on US 52, with a second northbound receiving lane on Morehouse Road. The proposed ultimate configuration of this intersection is shown in **Figure A17-3**. The additional intersection lanes described in this section have been separated

from the proposed US 52 widening because they can be constructed as an independent project prior to the widening in order to address existing congestion and safety problems.

The US 52/Morehouse Road intersection improvement project should also address existing problems at the adjacent Morehouse Road/Kalberer Road intersection. This intersection experiences delay during the peak periods, especially during the evening peak, when vehicles leaving the Purdue Research Park queue on the westbound Kalberer Road approach. The Morehouse/Kalberer intersection was not studied in detail, but a recent afternoon peak hour turning movement count suggests that it could possibly warrant signalization within the next five years. The additional new northbound receiving lane on Morehouse Road at US 52 should be constructed all the way from US 52 to Kalberer Road, where it would become a right-turn only lane. Closure of the cemetery entrance drive at the Morehouse/Kalberer intersection is also recommended, as this would allow operation to be improved by reducing the intersection size and adding a right turn island on the westbound Kalberer approach. Two alternate cemetery entrance drives are located within 500 feet of the intersection. Extension of two northbound lanes on Morehouse Road from US 52 to Kalberer Road and closure of the cemetery entrance at Kalberer Road are shown in **Figure A17-3** and included in the cost of the US 52/Morehouse Road intersection improvement project. Further improvements to the Morehouse Road/Kalberer Road intersection, including installation of a traffic signal and/or additional approach lanes, could be necessary to fully address operational problems but were not investigated in this study. Construction of a roundabout at this intersection could also be investigated, although the interaction between this intersection and the US 52/Morehouse Road intersection would need to be carefully considered.

5.2.4 Add lanes at the US 52/Cumberland Avenue intersection

In addition to the new through lanes on US 52, which are discussed separately, this intersection would require a second left turn lane on the northwestbound US 52 approach in order to meet vehicle Level of Service criteria in 2030. Cumberland Avenue would also be widened somewhat in front of the Applebee's property in order to provide two full receiving lanes for westbound vehicles leaving the intersection and to extend the eastbound left turn lane on Cumberland. This project includes replacement of the existing traffic signal and relocation of the signal pole from the median island on the west approach of Cumberland Avenue. The proposed ultimate configuration of this intersection is shown in **Figure A17-4**. The additional intersection lanes described in this section have been described separately from the proposed US 52 widening because they can be constructed as an independent project prior to the widening in order to address existing congestion and safety problems.

In light of the proposed Cumberland Avenue extension, the City of West Lafayette and INDOT may want to consider a more extensive reconstruction of this intersection as an alternative. This would involve realignment of Cumberland Avenue between Kent Avenue and the Wal-Mart entrance drive and re-grading of Cumberland Avenue west of US 52. This would improve the horizontal and vertical sight distance for drivers approaching the

intersection along Cumberland Avenue. These improvements would require moving the US 52/Cumberland Avenue intersection slightly to the south and would likely require the acquisition of the property on the southwest corner of the intersection. It is possible that property acquisition on the northwest corner could be avoided. A proposed alignment and cost estimate for this alternative intersection configuration have not been developed for this study.

5.2.5 Lengthen westbound left turn lane at the US 52/Cumberland Avenue intersection

An interim improvement would be made at this intersection by lengthening the existing single northwestbound US 52 left turn lane to provide at least 500 feet of storage. This would help to reduce existing congestion on this approach by reducing the instance of left-turning vehicles blocking the adjacent through travel lane on US 52. Analysis performed during this study found that it is not necessary or beneficial to extend this turn lane as far back as the Northwestern Avenue entrance ramp. This low-cost improvement could be combined with other short-term projects to improve traffic operation in the vicinity of Northwestern Avenue and Cumberland Avenue.

5.2.6 Modify Northwestern Avenue entrance merge

Modifications would be made to the horizontal and vertical alignment of the entrance ramp from Northwestern Avenue to westbound US 52 in order to move the merge point farther upstream and away from Cumberland Avenue. This would provide more space for vehicle weaving maneuvers between the ramp merge and the Cumberland Avenue intersection. The merge point of the entrance ramp has been moved approximately 560 feet in the conceptual layout developed for this study. **Figure A17-5** shows the proposed new location of the ramp.

5.2.7 Replace US 52/Northwestern Avenue interchange with at-grade intersection

The bridge carrying northbound Northwestern Avenue traffic over eastbound US 52 would be removed, and this interchange would be replaced by an at-grade intersection. The cost estimate for this project was developed based on the conceptual layout of a signalized intersection shown in **Figure A24**. Alternately, a 2-lane roundabout could be designed for this intersection. The project includes reconstruction of Northwestern Avenue from Neil Armstrong Drive to US 52 as a 4-lane urban section with curb and gutter and enclosed storm drainage.

An alternative to this project would involve removing the US 52/Northwestern Avenue interchange and using Yeager Road as the primary connection between US 52 and Northwestern Avenue. The costs and impacts of this alternative were not evaluated as part of this study, but this alternative may warrant further consideration and analysis in the future.

5.3 US 52 from Yeager to Nighthawk

Layouts were developed for each of the three alternative improvement concepts that were identified for this corridor segment in **Section 4.1.2**. These included the added travel lanes alternative, the median u-turn intersection alternative and the quadrant roadway intersection alternative. After consideration of project costs, benefits, impacts and public input, the median u-turn concept is recommended for implementation. The details of these alternatives are described in the following paragraphs.

5.3.1 Add through travel lanes on US 52 (not recommended)

A conceptual layout of the Yeager to Nighthawk segment of US 52 for the added travel lanes alternative is included in the Base Build Alternative layout shown in **Figure A17-6** through **A17-8**, and the 2030 intersection traffic operation under this alternative is included with the Base Build Alternative traffic operation shown in **Figure A18**.

Under this alternative, the segment of US 52 from 700 feet west of Yeager Road to 500 feet east of Nighthawk Drive would be reconstructed to add a third through travel lane in each direction. The road would have a 6-lane urban arterial typical section similar to that proposed between Morehouse and Cumberland. A multi-use trail would be constructed along the north side of US 52, and a sidewalk would be constructed on the south side. The center median would be widened to provide a better refuge for pedestrians crossing US 52. The existing enclosed drainage system would also be replaced to resolve ponding problems.

In addition to the added travel lanes on US 52, this project would also include the following intersection turn lane improvements:

- An additional through lane in both directions on Yeager Road at US 52
- An additional southbound left turn lane on Yeager Road at US 52
- An additional westbound left turn lane on US 52 at Yeager Road
- An additional through lane in both directions on Salisbury Street at US 52
- Lengthening of all left turn lanes at the US 52/Salisbury Street intersection
- A separate northbound right turn lane on Nighthawk Drive at US 52

5.3.2 Implement a median u-turn corridor along US 52 (recommended alternative)

A conceptual layout of the Yeager to Nighthawk segment of US 52 for the median u-turn alternative is shown in **Figure A19**, and forecast 2030 traffic operation is shown in **Figure A20**

Under this alternative, the segment of US 52 from 700 feet west of Yeager Road to 500 feet east of Nighthawk Drive would be reconstructed to prohibit all left turns at the Yeager Road, Salisbury Street and Nighthawk Drive intersections. Five new median u-turn intersections

would be constructed along the corridor to accommodate left turns diverted from the major cross streets. These intersections would be signalized. Two through travel lanes would be maintained in each direction on US 52. Existing curb and gutter would be reconstructed, and existing enclosed drainage would be replaced to resolve ponding problems. A multi-use trail would be constructed along the north side of US 52, and a sidewalk would be constructed on the south side.

Pavement widening would be required on the outside of the road at the median u-turn intersections in order to facilitate u-turn movements without widening the entire corridor. To minimize the impact on adjacent properties, it is proposed that only the widened areas west of Yeager Road and east of Nighthawk Drive be designed to accommodate u-turns by semi-trailer trucks. The areas between Yeager Road and Nighthawk Drive would be designed to accommodate u-turns by cars and single-unit trucks. However, signing at these loons would prohibit all truck turns and direct trucks to the appropriate location for turning. This is the design shown in **Figure A19**, where the u-turn areas at the ends were designed to accommodate a WB-50 truck and the areas in the middle were designed to accommodate a single-unit truck. It is desirable for all u-turn areas to accommodate truck turns, so consideration should be given to enlarging an area to accommodate large trucks if and when property adjacent to it is redeveloped. There is some flexibility to shift the widened areas somewhat from the locations shown in Figure A19, although careful consideration must be given to traffic signal progression and driveway accessibility if changes are made.

5.3.3 Implement a quadrant roadway intersection at US 52/Salisbury (not recommended)

A conceptual layout of the Yeager to Nighthawk segment of US 52 for the quadrant roadway intersection alternative is shown in **Figure A21**, and forecast 2030 traffic operation is shown in **Figure A22**

Under this alternative, the segment of US 52 from 700 feet west of Yeager Road to 500 feet east of Nighthawk Drive would be reconstructed. The intersections at Yeager Road and at Nighthawk Drive would be widened to provide three through lanes in each direction on US 52, plus the additional turn lanes as indicated in the added travel lanes alternative. The intersection of US 52 and Salisbury Street would be reconstructed to prohibit all left turns at the intersection, while providing two through lanes and a right turn lane in all directions. A new two-way road would be constructed in the northeast quadrant of the intersection, approximately from the intersection of US 52 with Covington Street to the intersection of Salisbury Street with Kent Avenue. These two existing intersections would be closed. All left turns at the US 52/Salisbury intersection would be diverted to this new quadrant road via signalized intersections with US 52 and Salisbury. Curb and gutter along US 52 would be reconstructed, and existing enclosed drainage would be replaced to resolve ponding problems. A multi-use trail would be constructed along the north side of US 52, and a sidewalk would be constructed on the south side.

5.3.4 Install advanced speed reduction sign on US 52 near Nighthawk Drive

This project would include two signing changes on westbound US 52 near Nighthawk Drive. First, the existing 40 mph speed limit sign just east of Nighthawk would be made more visible by trimming nearby trees or relocating the sign. Second, a "Reduced Speed Limit Ahead" sign (W3-5) would be placed along westbound US 52 between Soldiers Home Road and Nighthawk Drive to warn drivers of the reduction to 40 mph. These signing changes have been combined into a single project with the installation of the flashing beacon advanced signal warning sign near Klondike Road, which is described in Section 5.1.5.

5.4 Northwestern Avenue from Lindberg Road to US 52

5.4.1 Reconstruct Northwestern Avenue from Lindberg Road to Neil Armstrong Drive

The segment of Northwestern Avenue from Lindberg Road to Neil Armstrong Drive would be reconstructed to an urban typical section with curb and gutter, sidewalk and trail facilities, a raised median and enclosed drainage. Two travel lanes would be maintained in each direction. A conceptual layout of this reconstruction is shown in **Figure A23**.

5.4.2 Resurface Northwestern Avenue from Neil Armstrong Drive to US 52

Northwestern Avenue would be patched and resurfaced from Neil Armstrong Drive to the bridge over eastbound US 52. This project would be constructed as an interim improvement to address existing pavement problems, but would maintain the current shoulder and ditch design of the road. Reconstruction of this roadway segment to implement an urban typical section would be delayed until it is realigned to match the at-grade US 52/Northwestern Avenue intersection. The cost of this realignment and reconstruction is included in that project.

5.4.3 Add lanes at the Northwestern Avenue/Lindberg Road intersection

An additional eastbound and westbound through lane would be constructed on Lindberg Road and an additional northbound right turn lane would be constructed on Northwestern Avenue.

5.5 Traffic Signal Timing

All signalized intersections on US 52 and Northwestern Avenue within the study area are maintained by INDOT and coordinated together to provide arterial progression. It will be important to update traffic signal timing plans as the improvements recommended in this study are implemented. Signal timing updates will reflect changes in intersection approach

lanes, speed limits, and the implementation of new signalized intersections. Other timing changes may result from special circumstances. For instance, once the new roundabout is constructed at the Northwestern Avenue/Yeager Road intersection, it may be unnecessary to maintain traffic signal coordination between the Northwestern Avenue/Lindberg Road intersection and the intersections on US 52. In this case, retiming of the Northwestern/Lindberg traffic signal could result in a shorter signal cycle length and less delay at that intersection.

The City of Lafayette has recently implemented an advanced traffic management system that includes monitoring and coordination of approximately 80 traffic signals. It is envisioned that this system will eventually be expanded to monitor and coordinate traffic signals throughout the region. Coordination of the traffic signals on US 52 and Northwestern Avenue with other area signals through this regional system should be considered. Emergency vehicle preemption or transit signal priority could also be considered as part of a region-wide implementation.

Preliminary traffic signal timing plans were developed as part of the traffic analysis conducted for this study. These plans reflect ultimate project implementation and 2030 traffic forecasts, but they can be used as a starting point for final timing plan development during project design. Signal timing information developed during this study is included in the traffic analysis technical information provided separately to Tippecanoe County.

5.6 Estimated Project Costs and Impacts

Planning-level cost estimates were developed for each project by identifying the quantities of major cost items that would be required. **Table 5-1** on the following page provides a summary of all potential projects, along with their estimated implementation costs. Costs are estimated in 2010 dollars. The estimated right-of-way costs shown in the table are based on the area of land acquisition multiplied by a typical unit cost for land and land improvements in the project vicinity, as obtained from the Tippecanoe County Assessor's website. Cost estimating assumptions and details have been provided to Tippecanoe County in a separate document.

Additional costs would be incurred on some projects to compensate for damages to impacted properties. This could result, for example, from the need to acquire a building or from significant impacts to parking areas at commercial establishments. The anticipated number of properties requiring damage compensation for each project is identified along with the estimated right-of-way requirements in **Table 5-2**. However, these damage costs have not been estimated.

Table 5-1: US 52 Project and Preliminary Cost Estimates

Road	Limits	Improvement	Report Section Reference	Estimated Project Costs (2010 Dollars)[1]				
				Construction	Preliminary Engineering (10% of Construction)	Construction Inspection (15% of Construction)	Right-of-Way Acquisition[2]	TOTAL
US 52	Klondike Rd. to Morehouse Rd.	4-lane urban section	5.1.1	$7,080,000	$708,000	$1,062,000	$715,000	$9,570,000
US 52	At Klondike Rd.	Add turn lanes and modify signal	5.1.2	$575,000	$58,000	$87,000	$80,000	$800,000
CR 250 W	Immediately north of US 52	Realign road to US 52/US 231 intersection	5.1.3	$630,000	$63,000	$95,000	$0	$790,000
US 52	At future US 231 intersection	Add turn lanes and modify signal	5.1.4	$315,000	$32,000	$48,000	$0	$400,000
US 52	Near Klondike and Nighthawk	Warning sign improvements	5.1.5/5.3.4	$25,000	$3,000	$4,000	$0	$32,000
US 52	Morehouse Rd. to Northwestern Ave.	6-lane urban section	5.2.1	$9,555,000	$956,000	$1,434,000	$150,000	$12,100,000
US 52	Northwestern Ave. to Yeager Road	4-lane urban section	5.2.2	$960,000	$96,000	$144,000	$35,000	$1,240,000
US 52	At Morehouse Rd.	Add turn lanes and new signal	5.2.3	$805,000	$81,000	$121,000	$100,000	$1,110,000
US 52	At Cumberland Ave.	Add 2nd left turn lane on WB US 52 and new signal	5.2.4	$550,000	$55,000	$83,000	$15,000	$710,000
US 52	At Cumberland Ave.	Lengthen left turn lane on WB US 52	5.2.5	$85,000	$9,000	$13,000	$0	$110,000
US 52	Northbound entrance ramp from Northwestern Ave,	Relocate entrance ramp	5.2.6	$875,000	$88,000	$132,000	$0	$1,100,000
US 52	At Northwestern Ave. interchange	At-grade Intersection	5.2.7	$5,300,000	$530,000	$795,000	$0	$6,630,000
US 52	Yeager Rd. to Nighthawk Dr.	6-lane urban section	5.3.1	$10,205,000	$1,021,000	$1,531,000	$2,490,000	$15,250,000
US 52	Yeager Rd. to Nighthawk Dr.	4-lane with median u-turn intersections	5.3.2	$9,725,000	$973,000	$1,459,000	$700,000	$12,860,000
US 52	Yeager Rd. to Nighthawk Dr.	Quadrant roadway intersection at Salisbury. Widen at Yeager and Nighthawk	5.3.3	$11,045,000	$1,105,000	$1,657,000	$3,125,000	$16,940,000
Northwestern	Lindberg Rd. to Neil Armstrong Dr.	4-lane urban section	5.4.1	$1,760,000	$176,000	$264,000	$0	$2,200,000
Northwestern	Neil Armstrong Dr. to US 52 bridge	Resurface road	5.4.2	$145,000	$15,000	$22,000	$0	$190,000
Northwestern	At Lindberg Rd.	Add lanes and replace signal	5.4.3	$875,000	$88,000	$132,000	$590,000	$1,690,000

[1] Cost estimates are based on conceptual typical sections, preliminary feasible alignments and unit costs. Preliminary engineering has not been performed.

[2] Right-of-way acquisition cost estimates are calculated from the average per-acre value of the property and improvements. Potential damage payments are not included.

Table 5-2: Estimated Project Right-of-Way Impacts

Road	Limits	Improvement	Report Section Reference	Impacted Parcels		Parcels Requiring Damage Payments		Impacted Buildings	
				Residential	Commercial	Residential	Commercial	Residential	Commercial
US 52	Klondike Rd. to Morehouse Rd.	4-lane urban section	5.1.1	0	13	0	0	0	0
US 52	At Klondike Rd.	Add turn lanes and modify signal	5.1.2	1	3	1	1	0	0
CR 250 W	Immediately north of US 52	Realign road to US 52/US 231 intersection	5.1.3	1	1	0	0	0	0
US 52	At future US 231 intersection	Add turn lanes and modify signal	5.1.4	0	0	0	0	0	0
US 52	Near Klondike and Nighthawk	Warning sign improvements	5.1.5/5.3.4	0	0	0	0	0	0
US 52	Morehouse Rd. to Northwestern Ave.	6-lane urban section	5.2.1	0	5	0	0	0	0
US 52	Northwestern Ave. to Yeager Rd.	4-lane urban section	5.2.2	0	1	0	1	0	0
US 52	At Morehouse Rd.	Add turn lanes and new signal	5.2.3	0	2	0	0	0	0
US 52	At Cumberland Ave.	Add 2nd left turn lane on WB US 52	5.2.4	0	3	0	1	0	0
US 52	At Cumberland Ave.	Lengthen left turn lane on WB US 52	5.2.5	0	0	0	0	0	0
US 52	Northbound entrance ramp from Northwestern Ave,	Relocate entrance ramp	5.2.6	0	0	0	0	0	0
US 52	At Northwestern Ave. interchange	At-grade Intersection	5.2.7	0	0	0	0	0	0
US 52	Yeager Rd. to Nighthawk Dr.	6-lane urban section	5.3.1	3	43	2	41	0	0
US 52	Yeager Rd. to Nighthawk Dr.	4-lane with median u-turn intersections	5.3.2	0	19	0	15	0	0
US 52	Yeager Rd. to Nighthawk Dr.	Quadrant roadway intersection at Salisbury. Widen at Yeager and Nighthawk	5.3.3	8	43	7	31	2	5
Northwestern	Lindberg Rd. to Neil Armstrong	4-lane urban section	5.4.1	0	0	0	0	0	0
Northwestern	Neil Armstrong Dr. to US 52	Resurface	5.4.2	0	0	0	0	0	0
Northwestern	At Lindberg Rd.	Add lanes and replace signal	5.4.3	6	2	6	1	0	0

6 CORRIDOR IMPROVEMENT PLAN

6.1 Recommended Projects

Table 6-1 provides a summary of the projects recommended for implementation in the US 52 and Northwestern Avenue corridors, along with their estimated costs and recommended implementation time frames. Short-term projects are those recommended for implementation within the next 5 years. Medium-term projects are recommended for implementation between 5 and 15 years in the future. Long-term projects are recommended for implantation between 15 and 20 years in the future. These phasing recommendations are based on the severity of existing problems and anticipated time requirements for project development. The phasing of projects that are affected by the US 231 relocation is also based on the assumption that the new US 231 alignment will be constructed south of US 52 within the next 5 years but will not be extended north of US 52 for at least 15 years. The construction schedule for specific projects could be accelerated or delayed depending on many factors, such as the availability of funding.

It should be noted that the proposed project phasing categories would not necessarily create the lowest total cost of all projects combined. Some of the short-term projects represent interim solutions that would not need to be constructed if later recommended projects were in place. For example, the short term project to relocate the merge point of the Northwestern Avenue westbound merge with US 52 as discussed in section 5.2.6 would not be necessary if the long term project to replace the US 52/Northwestern Avenue interchange with an at-grade intersection was implemented as a short term project. Likewise, combining several of smaller projects into one larger project would produce some economy of scale savings. As funding levels are identified, project phasing will need to be reevaluated to determine the most cost-effective implementation schedule.

Table 6-1: US 52 Corridor Study Recommended Projects

Project	Road	Limits	Improvement	Report Section Reference	Estimated Implementation Cost (2010 dollars)	Estimated Impacted Properties
Short-Term Projects						
S-1	US 52	At Klondike Rd.	Add turn lanes and modify signal	5.1.2	$800,000	4
S-2	CR 250 W	Immediately north of US 52	Realign road to US 52/US 231 intersection	5.1.3	$790,000	2
S-3	US 52	Near Klondike and Nighthawk	Warning sign improvements	5.1.5/5.3.4	$32,000	0
S-4	US 52	At Morehouse Rd.	Add turn lanes and new signal	5.2.3	$1,110,000	2
S-5	US 52	At Cumberland Ave.	Lengthen left turn lane on WB US 52	5.2.5	$110,000	0
S-6	US 52	At Cumberland Ave.	Add 2nd left turn lane on WB US 52 and new signal	5.2.4	$710,000	3
S-7	US 52	Northbound entrance ramp from Northwestern Ave,	Relocate entrance ramp	5.2.6	$1,100,000	0
S-8	Northwestern	Neil Armstrong Dr. to US 52 bridge	Resurface road	5.4.2	$190,000	0
S-9	Northwestern	At Lindberg Rd.	Add lanes and replace signal	5.4.3	$1,690,000	8
Mid-Term Projects						
M-1	US 52	Morehouse Rd. to Northwestern Ave.	6-lane urban section	5.2.1	$12,100,000	5
M-2	US 52	Northwestern Ave. to Yeager Road	4-lane urban section	5.2.2	$1,240,000	1
M-3	US 52	Yeager Rd. to Nighthawk Dr.	4-lane with median u-turn intersections	5.3.2	$12,860,000	19
M-4	Northwestern	Lindberg Rd. to Neil Armstrong Dr.	4-lane urban section	5.4.1	$2,200,000	0
Long-Term Projects						
L-1	US 52	Klondike Rd. to Morehouse Rd.	4-lane urban section	5.1.1	$9,570,000	13
L-2	US 52	At future US 231 intersection	Add turn lanes and modify signal	5.1.4	$400,000	0
L-3	US 52	At Northwestern Ave. interchange	At-grade Intersection	5.2.7	$6,630,000	0

[1] Cost estimates are based on conceptual typical sections, preliminary feasible alignments and unit costs. Preliminary engineering has not been performed.

6.2 Other Recommendations

In addition to the specific corridor improvement projects identified in **Table 6-1**, several additional recommendations were provided in this study and are summarized below. Each summary recommendation includes a reference to the section of this report that provides more detail.

Additional projects

The City of West Lafayette, Tippecanoe County and INDOT may want to consider the following projects for implementation in the US 52 corridor:

- Signal installation at US 52/Wyndham Way, if warranted by future development (Section 5.1.7)
- Improvements to the Morehouse Road/Kalberer Road intersection (Section 5.2.3)
- Realignment and re-grading of Cumberland Avenue between Kent Avenue and the Wal-Mart entrance drive, including relocation of the US 52/Cumberland Avenue intersection (Section 5.2.4)

Alternate corridor capacity west of Morehouse

It is recommended that the City of West Lafayette and Tippecanoe County consider the need to provide alternate routes to divert local access from US 52 west of Morehouse Road. The costs and benefits of new parallel roads in the US 52 corridor should be investigated as part of a future regional transportation plan update before land development makes their construction infeasible. This is discussed in Section 4.1.1 of this report.

Alternate commercial access between Yeager and Nighthawk

It is recommended that the City of West Lafayette consider the potential to provide a network of parallel roads to move most or all commercial access off of US 52 between Yeager Road and Nighthawk Drive. This concept should be studied for implementation over the long term in order to help provide a more livable and walkable commercial corridor as the area is redeveloped. This concept is described in greater detail in Section 4.1.2.

Bicycle and pedestrian improvements

Proposed sidewalk and trail facilities in the corridor are shown in **Figure A-14** and facility recommendations are discussed in Section 4.2. Many of the identified facilities have been included in the preliminary layouts and the estimated costs of adjacent road improvement projects proposed in this study. New sidewalks and trails should be connected to nearby existing facilities, and both new and existing facilities should be brought into compliance with the Americans with Disabilities Act. Crossing locations at major intersections should be designed to safely accommodate pedestrians and cyclists, including crosswalks, pedestrian signal indications and median refuge areas. In some locations, separate facilities located

outside of the US 52 right-of-way could provide better access to destinations in the corridor, and construction of these facilities should be pursued as development opportunities allow.

Gateway enhancements

It is recommended that the City of West Lafayette, Tippecanoe County and INDOT pursue the implementation of gateway enhancements at the locations described in Section 4.3 of this report and shown in **Figure A15**. The next step would be a design study to identify the desired level of treatment in enhancement areas, specific design elements to be included, design themes, estimated costs and potential funding sources.

Access management

It is recommended that the City of West Lafayette, Tippecanoe County and INDOT enforce appropriate access management policies during the roadway design, site development approval and driveway permitting processes in order to limit or reverse the negative impacts of property access on US 52 traffic flow and safety. These access management policies should comply with INDOT's *Access Management Guide* and provide standards for the design and spacing of intersections, driveways and crossovers. Specific examples of appropriate access management criteria used by INDOT are identified in Section 4.4.

Demand management

Finally, it is recommended that the sponsoring agencies of this study work together with the City of Lafayette, Purdue University, CityBus and other organizations on efforts to reduce single occupant vehicle travel on a community-wide basis. Many of the projects recommended in this study are based on forecasts of continued growth in vehicular traffic demand. Reducing the growth in traffic demand could delay the need for expensive capacity improvements in the corridor. Construction of bicycle and pedestrian facilities will improve conditions for walking, cycling and transit in this corridor, but it is unlikely to have a significant impact on single occupant vehicle demand by itself. Slowing traffic growth in the US 52 corridor will be most effectively addressed by regional policies that affect land use, housing and transit service.